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EDITORIAL

Bound and Free Water

WATER is the one chemical of which every layman knows the formula; the chemist has broken it down into its elements and synthesized it from them; it has a pre-eminent rôle in the reactions of the living organism. Yet it is only recently that the physiologist and the biochemist have begun to study it and to realize that there is an essential difference between free and bound water, so that in living tissues and inanimate colloidal systems a greater or smaller fraction of the water is part and parcel of the organic system and is not at liberty to take immediate part in a reaction such as hydrolysis. Some chemists have a conception of active water as consisting of single and simple molecules of H_2O, whereas inactive water is composed of many molecules $(H_2O)_x$ which must first be simplified before they can take part in a reaction. The attempt has been made to develop an experimental technique to measure the proportions of bound and free water. Defining the bound water as that portion of the total which does not freeze at $-20°$ C., it is possible to measure the latent heat of the melting ice or still better to determine in a dilatomer the expansion of the system due to ice formation as the free water freezes. The method has proved a reliable one and it is giving an insight into many problems of wider interest than the mere behaviour of colloids. For instance, when wheats and grasses are placed in the order of their known ability to resist drought, it is found also that there is a regular descending order of bound water content from the most to the least drought-resisting species, or in other words, much bound water indicates hardiness to drought. Resistance to cold, both in plants and insects, has been studied by a similar cryoscopic technique: insects which resist cold contain a minimum of free water in their tissues and the bound water increases during the preparation for hibernation. Water relations appear to have a marked effect on the nervous system and may even cause insanity: Bancroft, for example, has suggested that the various types are due either to an increased dispersion or an increased coagulation of the brain colloids. From the more general aspect of synthesis and hydrolysis *in vivo* as controlled by enzymes, we have been aware for some time of the predominating influence played by water in determining which course the reaction should take, where it should stop, realizing also that it was the active water and not the total water in the system which acted as the controlling agent. Although these facts are well established, they do not seem to be as widely realized among physical chemists as is perhaps desirable, so that elaborate explanations are often offered to explain what is really only due to the control exercised by the reaction

$$\text{bound} \rightleftharpoons \text{free water}.$$

In quite another sphere H. B. Baker has taught the effect of the smallest traces of water in influencing chemical reactions which fail to materialize between absolutely dry substances. In the cell, where the reactants are organic colloids, the setting in of a reaction is influenced by the variation in amount of free water in a system where the total water is large in proportion and remains approximately constant in amount. If it be true that the chemist thinks in architectural molecules and the biologist in tissue of cells, they must descend from their respective heights to the sea level to consider happenings in terms of active water. Carlyle has told us that man's mission is order, to make what was disorderly, chaotic, into a thing ruled, regular. This is above all the mission of the chemist, who, as he unravels the secrets of nature, so complex in their entirety, is always finding fresh evidence to prove how simple are the means employed to obtain the result.

Moissan

Our friends and colleagues, *Chimie et Industrie*, have recently sent us a handsome volume of about a hundred pages giving an account of the life and scientific work of Henri Moissan and a description of the homage rendered to him by many eminent men of science on the occasion of the inauguration of a monument to his memory in the form of a plaque erected opposite the College at Meaux on the 4th October, 1931. Moissan was born in Paris in 1852 of humble parentage, his father being a railway employé and his mother a dressmaker. He obtained a situation in a pharmacy at Meaux and by sheer hard work and devotion to study acquired a thorough knowledge of inorganic chemistry and permission to work in a laboratory. In 1882 when he was thirty years old he was appointed a professor at the École supérieure de Pharmacie where he had better opportunities of doing research. After a few years of experimenting he succeeded in 1886 in isolating fluorine and afterwards made a careful study of the properties of this difficult element. With the aid of a powerful electric furnace, in which he was able to devise important improvements, he prepared some artificial diamonds of no commercial value. He published papers on the boiling points of osmium, ruthenium, platinum, nickel, iron, chromium, and several other metals and on the distillation of many of these. He died in February 1907 from a sudden attack of appendicitis.

INDUSTRIAL USES OF RUBBER LATEX*

By D. F. TWISS

It is well known that although travellers of the 16th century recorded the fact that South American natives produced various rubber or rubbered articles with the aid of latex, rubber manufacture in civilized countries was originally based on the use of dry rubber. At first the balls of dry rubber, as received from South America, were cut to form various articles, *e.g.*, rings, strips, or sheets, and it was the need to reconsolidate the resulting scrap that impelled Thomas Hancock, the "Father" of the rubber industry, to the discovery of the mastication process in 1820. The alternative method of handling rubber for manufacturing purposes at that time was by forming a solution in a suitable solvent such as turpentine and to use this for waterproofing and similar purposes. The discovery of the mastication process led further to the observation that such masticated rubber dissolves much more easily than unworked rubber, and that the solutions obtained for any particular rubber content are much less viscous. Mastication, however, also results in changes which emphasize the shortcomings of raw rubber with respect to certain physical characteristics especially mechanical strength and the adverse effect of heat and cold. The need for artificial improvement of the quality of such rubber was satisfied by the discovery of vulcanization about 1842. It will be seen consequently that the position which developed in connexion with the use of rubber in fluid form was in reality irrational. In order to make a satisfactory rubber solution, material obtained from a fluid latex of considerable rubber content, for example 35%, was dried, subjected to mechanical working—whereby its mechanical properties suffered—and dispersed in a rubber solvent producing a solution of lower rubber content and much lower fluidity than the original rubber latex.

It is easy to appreciate therefore, that the advantages of latex as a form of rubber for manufacturing purposes must frequently have been entertained by rubber manufacturers. Thomas Hancock himself in 1824 tried rubber latex for converting cheap fibrous material into an artificial leather, and he filed a patent for the process. It is of importance to note that this process actually preceded an alternative one patented by him in 1825 with the same aim, but using rubber solution. Unfortunately this latex process, together with other latex processes of Hancock for the impregnation and coating of ropes and cordage patented in 1825, and for proofing with latex patented in 1830, experienced an effective check through the inability to obtain substantial supplies of rubber latex.

Thomas Hancock was convinced of the practicability of latex transport, but was unfortunate in two respects. The small quantities of latex which he secured for his small-scale experiments appear to have been wrongly described to him as Hevea latex. Consequently when he appointed an agent in Tampico to export Hevea latex in bulk, the deliveries of the much less stable Hevea latex arrived repeatedly in a coagulated condition and necessitated abandonment of his latex processes. Also, only at the time of the writing of his memoirs many years later was he in a position to record the fact that ammonia had been found to be an effective preservative for latex, this discovery having been made about 1853.

The development of the plantation method of production of rubber permitted a greater degree of control than previously over the conditions of separation of rubber from the latex, so that the resulting product was of more uniform character than the range of various grades of wild rubber previously available and the rubber even in an unvulcanized—and unworked—condition already possessed fair mechanical qualities. This feature was emphasized a few years later by the use of unvulcanized crêpe rubber for the soles of sports shoes and other footwear. The results emphasized the fact that the mastication process, although necessary as an intermediate stage in the existing methods of manufacture, is not in itself beneficial to the mechanical strength of the rubber, and that from this point of view the direct application of latex to the manufacture of rubber articles should enable the natural mechanical strength of the rubber to be realized more fully. It was probable for such reasons that there was about 1920 a renaissance of interest in the possibilities of latex. The number of patents for latex processes must now reach several thousands.

In a paper such as this it is clearly not possible to deal at length with individual inventions and it must suffice to mention various types of processes illustrative of the underlying principles. A critical study of the patent literature (a useful selection from which is given in a recent booklet on "Rubber Latex," published by the Rubber Growers' Association) will give additional detailed information.

Somewhat surprisingly the reduction in the price of raw rubber of recent years has not been altogether favourable to the adoption of latex processes. A reason for this is that the small premium on the price of latex rubber for special handling and additional transport charges becomes a much greater percentage of the cost of raw rubber when the latter is near 2d. a lb. than when it is 2s. per lb. On the other hand however, the reduction in the cost of raw rubber has increased the advantages of latex for purposes which cannot well be served by ordinary rubber and where latex has to compete primarily with non-rubber materials. By concentrating latex on the plantations it has been possible substantially to reduce its bulk and weight and consequently the transport charges and to-day the greater portion of the latex exported (nearly 10,000 tons of dry rubber in 1932) contains less than one-half its weight of water. The latex is transported mainly in steamer tanks (preferably wax-lined), in drums (of 40—65 gal. capacity), and in 4-gal. tins.

Technical Advantages

The main advantages of latex are as follows: (1) The rubber is available in a fluid condition without the cost and the ill-effects of mastication. The latex is easily used for purposes such as spreading or soaking; further it can be compounded without the need for heavy machinery involved in ordinary rubber manufacture. (2) Latex contains a much higher proportion

* *Read before a joint meeting of the Yorkshire Section and the Plastics Group on March 27, 1933.*

of rubber than rubber solutions of equivalent viscosity. The proportion of volatile medium to be removed is therefore considerably less. (3) Not only is the cost of the rubber solvent eliminated, but the fire risk and health hazards of the common solvents are obviated. (4) Latex, by induced coagulation, readily yields solid rubber (admittedly wet) when required, whereas solutions normally have to be evaporated more or less completely. Articles can therefore be removed at an early stage from formers, moulds, etc., permitting the rapid return of these to the cycle of operations. (5) On account of the avoidance of the development of heat which arises in the milling of raw rubber, it is possible to use freely the most powerful accelerators of vulcanization in latex-compounding without fear of trouble from scorching or premature vulcanization. The low temperature of eventual vulcanization permits the use of bright organic pigments which would be discoloured in ordinary heat vulcanization. (6) The latex rubber products normally contain a full proportion of the natural anti-oxidant constituents of the latex and so, *ceteris paribus*, show better ageing qualities in addition to the greater mechanical strength arising from the unworked condition of the rubber.

Features of latex constituting possible disadvantages are: (1) The need of a small proportion of some form of preservative or stabilizing agent, *e.g.*, 0·5% of ammonia or 1% of potassium hydroxide. (2) The need for removal of water at some stage of manufacture. (3) The lower stability relative to rubber solutions, for example, for storage. On the other hand this lower stability is a distinct advantage for some operations. (4) The incorporation of reinforcing agents to the full effect of the latter is at present more difficult than with dry rubber.

Modifications of Rubber Latex for Manufacturing Purposes

Compounding.—In view of the fact that rubber for commercial purposes is generally required in a vulcanized condition, it is customary to use latex more or less compounded. Compounding is easily effected by adding the materials after wetting or dispersion in water. Sulphur, accelerators, and the usual powders are easily incorporated in this way. It is important that they should at least be wetted before incorporation. It is further desirable that they should be made faintly alkaline preferably with a small quantity of ammonia. As a still further refinement they may be added in the form of colloidal, or almost colloidal, suspensions, in which case a small quantity of a dispersing or stabilizing agent, such as casein, gum arabic, or gelatin, may be mixed with them. Colloid mills are of use in this connexion, but mainly to ensure complete wetting of the powders and the effective disintegration of the agglomerates before addition to the latex. A ball mill can effectively aid the wet dispersion of powders for latex-compounding. Precipitable powders such as barium sulphate may even be formed in the latex itself using the latter as the precipitation medium. Oils, bitumens, etc. also are introduced in the form of colloidal dispersions, the production of which is generally assisted by a small percentage of ammonium soap and is facilitated by the use of a colloid mill. Some compounding ingredients which are otherwise difficult to disperse satisfactorily, *e.g.*, certain anti-oxidants, can be dissolved in the oils before these are emulsified. Fatty acids, such as oleic acid or stearic acid, are desirably introduced in the form of their ammonium salts, the acid being eventually liberated by the substantial loss of ammonia during drying. By compounding *before* concentration, exceptionally uniform and permanent dispersion of compounding ingredients is possible. In the production of thin rubber goods it is possible to introduce rubber-soluble compounding ingredients, especially accelerators of vulcanization, by diffusion, *e.g.*, from an aqueous solution or dispersion into the unvulcanized article; this procedure of course is equally applicable to thin articles made from sheet rubber or rubber solutions. In the following discussion the term "latex" will frequently be used to include latex suitably compounded with vulcanizing agents, pigments, and other modifying ingredients.

Adjustment of viscosity and concentration.—For many purposes, for example, for spreading or dipping, natural latex although containing about 35% of rubber may be inconveniently fluid; it may for this reason permit sedimentation (or creaming) of compounding ingredients. To prevent this the viscosity can be increased by several methods, of which the following are typical:

(1) The use of colloidal materials such as albumin, gum tragacanth, or even milk for this purpose was protected by patent as long ago as 1855. It is possible that in the case of milk, in addition to the effect of casein, the thickening occurs to some extent by absorption of fat by the latex globules. The addition of rubber solvents to latex can also effect a thickening. In other cases powders such as clay or bentonite may be added in such proportion as to render the latex so thick that it may even become thixotropic. Other thickening agents such as zinc oxide and certain zinc salts appear to act by causing partial coalescence of the rubber globules. Reference must here be made to the important possibility of modifying the surface tension of latex and increasing its wetting and penetrative power towards fabrics by the addition of a small proportion of colloidal material of the "wetting agent" type, certain complex organic sulphonates being particularly powerful.

(2) A simpler and generally more satisfactory method for increasing viscosity is by concentration. By centrifuging in a special separator, concentrate is to-day being produced of 60% rubber content. The centrifuging incidentally serves to effect purification from foreign suspended material. Dunlop 60% latex (also marketed as "Jatex") is so produced.

Creaming may also be expedited by special agents such as gum tragacanth or ammonium alginate, the effect being presumably analogous to that of sedimentation of wine by colloids such as isinglass. With small additions of the creaming agent static latex in the course of a few hours gives a cream containing 60% or so of rubber; the presence of the additional creaming agent is not serious for many purposes. "Lotol" is a concentrate of this class. Filtration has been successfully applied on an experimental scale in Italy to the production of latex concentrate. Evaporation, either

before or after compounding, provides another method for producing a thickened latex (*e.g.*, Revertex) for manufacturing purposes.

(3) Minor adjustments of the viscosity are possible also in other ways, *e.g.*, by variation in the degree of alkalinity of the latex.

Vulcanization.—Instead of applying compounded latex to the primary production of an unvulcanized rubber article which is vulcanized in a subsequent operation, generally after drying, it is possible to effect vulcanization even in the aqueous dispersion itself (P. Schidrowitz, 1921). If stabilized latex containing sulphur in dispersion is heated to vulcanizing temperature the individual rubber globules actually become vulcanized. On subsequent removal of the water, for example, by evaporation, the vulcanized globules coalesce to form a continuous rubber mass. It is convenient for such vulcanization of latex to make use of powerful accelerators of vulcanization, also in a state of dispersion or solution, in order that the vulcanization process may be capable of occurring below 100° C. If the vulcanization process is carried too far not only is there a danger of impaired ageing in an over-vulcanized article, but the coalescence of the rubber globules on drying is less complete and the rubber product may show signs of "shortness."

In view of the ease with which latex can thus be vulcanized, the difficulty of introducing reinforcing agents inside the rubber globule without some degree of milling appears somewhat surprising. The essential difference however, doubtless lies in the solubility of sulphur in rubber, whereas the particles of agents capable of reinforcing rubber are not soluble in that medium but nevertheless need to be very intimately dispersed therein.

Flocculation.—Although rubber latex for most technical purposes not only contains a preservative such as ammonia, but also is additionally stabilized by the addition of suitable colloids in small proportion, such as casein or ammonium soap, coagulation for some purposes may occur with inconvenient ease, *e.g.*, ordinary latex is difficult to mix intimately with some powders and also with certain fibrous materials on account of a tendency to localized or irregular coagulation. This feature can be obviated by effecting incipient coagulation so as to produce a still fluid dispersion, or even paste, of coarser particles in which the sensitiveness towards formation of a continuous coagulum is no longer present. Indeed the resulting flocculated latex can be regarded as a fine dispersion of rubber coagulum. Flocculation can be effected in a number of ways, generally by the use of a carefully selected coagulant under adjusted conditions; a solution of an aluminium salt has often been used. Such flocculated latex or "latex precipitate" can be used with especial advantage for mixing with fibres for the production of rubberized fibrous dispersions, which by filtration, screening, or other means of consolidation can be formed into sheet or other convenient shape. By combining in this way rubber and disintegrated textile or leather waste it is possible to make an artificial leather or leather substitute of attractive properties. A mixture of asbestos and rubber so produced can be consolidated for brake-linings. Indeed the possible applications of such "latex precipitate" are numerous. Furthermore, it can be freed from saline or other undesired soluble constituents by washing, *e.g.*, by decantation or other convenient means.

Crumbing.—If the flocculation of latex, especially of highly compounded latex, is carried further, a wet crumb-like mass is obtained which can be dried to form a compounded rubber powder. Such compounded rubber crumb can also be produced by simultaneous compounding and coagulation, for example, by successively adding to ordinary latex two reagents such as sodium silicate and magnesium sulphate. On addition of the second reagent a fine precipitate of compounding ingredient is formed concurrently with flocculation of the rubber globules, and a discontinuous crumb-like mass is obtained. The dried products can be used for manufacture of soft rubber and also ebonite articles by a simple moulding operation in the same way as an ordinary moulding powder.

Methods of Use

The methods by which latex may be used in manufacture fall generally within the following group of processes: spreading, soaking, spraying, dipping, electrophoresis, gelling, frothing, flocculation, crumbing, and moulding. These terms are used in a wide sense, for example, spreading and dipping cover also such uses as the application of latex either as an adhesive for assembling in boot and shoe manufacture or as a bonding agent for abrasive or other materials.

Some applications of latex, for example, proofing by spreading, simple bonding of abrasives and asbestos or other fibres and the provision of anchorage for the pile of carpets and the bristles of brushes, although offering advantages, are so obvious in theory that the processes instanced below are those with special features or illustrative of various principles. The order of consideration is not selected to bear any relation to the degree of present technical importance.

Anode process.—This interesting process is based on the well-known electrophoretic movement of the particles in a colloid suspension when subjected to electric stress betwen two electrodes. The rubber globule normally carries a negative electric charge and so normally tends to migrate towards the anode; hence the term "anode process." (It is possible, *e.g.*, by acidification in the presence of an appropriate stabilizing agent, to make the rubber globule assume a positive electric charge and to reverse the direction of the electrophoresis so that migration occurs to the cathode. Such cathode-deposition of rubber is not found in technical application.) In the passage of an electric current through compounded latex there is naturally a tendency for any electrolytes present to carry much of the current. This not only increases the liability to liberation of gases at the electrodes, the anode of course being the more important in the present consideration, but also reduces the yield of rubber deposited per unit of current.

The so-called "deposition factor" given in terms of grams of dry rubber per ampere-minute of current in good practice may exceed 3. It is therefore desirable to reduce the electrolyte content before using latex for electrophoretic manufacture and also incidentally as far

s possible to ensure that such residual electrolytes as are present are not unduly prone to cause anodic gassing with reasonable voltages. Ammonia-preserved latex onsequently is superior to caustic-alkali preserved atex because of the ease with which the ammonia can be ubstantially removed either by evaporation or aeration r even by the careful addition of formaldehyde which onverts it into hexamethylenetetramine. From the oint of view of freedom from electrolytes the concenration of latex by centrifuging has advantages for lectrodeposition. Concentration in itself is not a ughly important matter for the anode process, but entrifugally concentrated latex on re-dilution to the ubber content of normal latex naturally shows a disinctly lower proportion of saline serum substances. For he more complete removal of natural saline constituents f the serum and of any caustic alkali preservative, ialysis can be used.

The "anode" process can be applied equally well to he production of permanent protective rubber or bonite coatings, *e.g.*, on metal wire screens, ships' fittings, tc. and to the manufacture of rubber articles.

For the production of rubber articles of simple shape, uch as motor tubes or rubber sheet, the rubber is onveniently deposited directly on the anode for which he most suitable metal is zinc because it undergoes nodic dissolution where a nobler metal would resist nodic attack and cause formation of bubbles of gas on he anode. The anode may be entirely of zinc or merely inc plated. It is desirable to keep the anode voltage elow the decomposition potential for water.

For articles of more complex shape a method is posible which incidentally obviates the danger of porosity rom anodic gases. The anode is surrounded by a porous iaphragm of the desired shape. This porous surround lso conveniently contains a solution of a saline substance f which the cation is a coagulant for rubber. In these ircumstances the compounded rubber is deposited as a vet but tenacious layer which may be built up to half an nch in thickness and only needs to be dried and vulanized. In this connexion it must be emphasized hat the wet rubber deposit is reticular in structure, ut consolidates naturally during drying. In the freshly eposited condition it is permeated by the aqueous nedium and freely permits the passage of the electric urrent. Another feature which should be mentioned s that as the bath is normally kept agitated actual lectrophoretic movement is not responsible for bringing he globules of rubber and the particles of compounding ngredients to the surface of the anode or of the porous node "surround," the main electrical effect being the eposition of a coherent rubber layer.

The anode process can be applied to the manufacture f many types of important articles including such as ave fabric reinforcement, but it has to compete with mpler dipping processes (see later). It has however, articular advantages for the rubbering of metal wire creens and for the production of rubber sheets in which complex perforated pattern is necessary. An example s provided by the Charnaux rubber corset which has n intricate pattern of ventilation holes. The perfortions which in manufacture by old methods were ntroduced by hand punching now result from nondeposition of rubber on small ebonite studs inserted in the zinc anode.

By modification of various factors such as the degree of alkalinity of the latex and the proportion of stabilizing agents and of additional electrolytes present, it is possible to adjust the consistency and water content of the rubber deposit obtained by anode deposition. It is also practicable to arrange for the deposit to be of different thicknesses in various parts by suitably screening or shaping the electrodes and adjusting their distance from one another and by other devices enabling modulation of the distribution of the current over the anode. An additional important feature of the anode process is that it permits automatic adjustment of the concentration of the rubber dispersion. The deposition of the compounded rubber on the anode naturally tends to weaken the bath, but by enclosing the dispersion in an appropriate porous ceramic or asbestos diaphragm and placing the cathode outside this in dilute aqueous ammonia, it is possible by electric endosmosis to cause serum to flow from the dispersion into the cathode space at such a rate that the latex dispersion remains constant in composition and concentration and needs merely to be replenished so as to maintain the necessary depth.

Dipping process.—The principle of this process can be applied in a variety of ways. A plain dipping process can be used for the production of such articles as sacs for fountain pens and other purposes, tobacco pouches, rubber shoes, teats, surgeons' gloves, etc. The dipping process can be used with ordinary latex (which customarily will have been compounded), but in order to reduce the number of immersions to build up an article of the necessary stoutness of wall, latex of increased viscosity and also increased concentration is to be preferred. With compounded latex which has been concentrated to a content of about 60% or 70% of total solids it is possible by one or two immersions of the dipping former (conveniently of aluminium or glass) to produce an article which by dipping with ordinary rubber solution would require almost as many dozen immersions. It is convenient to effect surface coagulation of the deposited film by momentary immersion in a coagulant, *e.g.*, dilute acetic acid or even acetic-acid vapours. The first layer is thereby prevented from distortion or slippage during subsequent operations such as drying or further dipping, only one drying operation being necessary even for an article built up by several immersions. Indeed by stripping the wet article from the form at this stage, drying of the hollow wet rubber is expedited and the form can be returned at once to the cycle of operations. Vulcanization can be effected during the drying or subsequently.

The condition of the final latex coating before coagulation permits the development of noteworthy decorative effects. If the final film of latex has the necessary degree of stability, it is possible by immersion in an aqueous coagulant of relatively high specific gravity to cause the formation of localized breaks and folds in this final layer with production of an attractive "crocodile skin" effect. On immersing the dipping former with its wet latex coating for 2 minutes in a mixture of swelling agent and coagulant (*e.g.*, benzene 40 vol., acetic acid 1 vol.) there results an attractive corrugation

of the surface whilst the additional presence of a non-solvent for rubber (*e.g.*, alcohol 40 vol.) in the bath leads to a fine surface-wrinkling of a type advantageous to such articles as surgeons' gloves. It is also possible to produce a matt finish on the uncoagulated latex surface by dusting with a water-soluble powder such as common salt. Colours or even coloured latex can also be applied by spraying or by dipping, the colours in the latter case being either in solution or dispersed in water or merely floating as films on water. Thus it is possible to produce either a uniform colour or a mottled or marbled effect.

In order further to facilitate the production of articles of considerable thickness from latex, whether concentrated or not, a very useful device is that of so-called ionic deposition or coagulant dipping. The dipping former in this case is coated with an adherent film of coagulant (which can easily be arranged in various ways) and is then immersed in the latex. The migration of the coagulant into the surrounding latex expedites manufacture not only by rapid formation of a shaped coagulum, but also by reduction of the number of immersions necessary for thick deposits; many types of article can thus be produced. By varying the thickness or concentration of the coagulant film on the former it is possible to obtain products with localized thickening, so that in the manufacture of rubber gloves the palms and the front of the fingers can be made stouter than the remainder. It is possible by ionic deposition to produce rubber boots and shoes not only of plain rubber, but with fabric reinforcement. Even industrial boots and Wellingtons can be thus manufactured, but the thick soles are conveniently prepared by the old method from masticated rubber. A simply produced article of distinct utility is a fabric-lined glove with a rubber exterior produced by fitting a cotton glove on a former; the surface of the fabric is then damped with a dilute alcoholic solution of acetic acid and immersed in the latex. On withdrawal after a few seconds and subsequent drying and vulcanization the article is complete. It is of interest that ionic deposition probably plays an important part in the anode process: in the case of an anode surrounded by a porous diaphragm which constitutes the shaped mould, ionic deposition must be the main channel of action of the electric current. Even with deposition directly on a metallic anode, after the anode has once become coated with a continuous film of coagulum the further deposition of rubber must follow by electrically aided migration of metallic ions from the anode through the permeable wet coagulum.

A further device to effect controlled deposition of rubber from latex on to a shaped surface is by so-called heat-sensitization. There is added to the latex in this case a small proportion of some agent, *e.g.*, calcium sulphate, certain organic accelerators of vulcanization, a mixture of zinc oxide and an ammonium salt or of ammonium persulphate and a reducing agent, which at higher concentrations or at higher temperatures would be capable of inducing coagulation. The treated latex, however, is of reasonable stability and remains in good condition for considerable periods at the ordinary temperature. On immersion of a hot former into such heat-sensitized latex a layer of rubber coagulum is gradually built up, and when of the desired thickness can be removed with and dried on the former. An interesting development has been the recent successful commercial application of heat-sensitive latex to the manufacture of hollow articles such as play balls (see later).

Filtration has been commercially applied in U.S.A. as a method for the production of motor tubes by immersing a perforated mandrel coated with superposed layers of fabric and cohesive wet powder such as clay in compounded latex; the serum passes through to the interior of the mandrel, which is under reduced pressure, and a compact coating of wet compounded rubber gradually forms on the outer surface.

Spreading, which may be considered as a special case of a dipping process, is to-day applied in many different ways, and in some directions on a very large scale for manufacturing purposes. Large quantities of latex variously compounded are used as or in adhesive or stiffening material in the manufacture of ordinary shoes (in preparing constructional parts and in making cutting-blocks), the consumption in this direction in 1930 being equivalent to 8,000,000 lb. of rubber. Large quantities are also used for the sealing of millions of cans, the seam in the side of the can and between the side and the base being filled with a core of rubber composition which is applied in the form of a latex paste. Latex is also used on a large scale for proofing textiles of all kinds, *e.g.*, for raincoats and for producing spread rubber sheet.

Horse hair or similar fibre for upholstery is treated in its final expanded condition with compounded latex so that after drying and vulcanization, the relative position of the individual strands is fixed giving increased resilience and permanence of shape. A mixture with gelatin or with gelatin and glycerol has been applied to reduce the permeability and consequent leakage of gas-bags for airships and of inner-tubes for motor tyres.

One of the early suggestions in the latex "renaissance" was that of F. Kaye in 1920 for its use as a sizing material in paper manufacture. Although this suggestion has not been adopted as widely as seemed likely at first, it contained the germ of the idea for the use of latex in bonding fibrous materials generally. To-day, latex is used largely as a binding agent, *e.g.*, for bonding abrasives, and to convert leather dust or disintegrated fibre into artificial leather, to consolidate crumbed rubber waste into various products and, mixed with emulsified wax, to proof cork lids and cardboard containers. Large-scale experiments are in progress in different parts of the world on its application as a binding material with or without cement for road construction and surfacing. In this direction a mixture of stabilized latex with cement and with or without other fillers (including emulsified bitumens) is of especial promise. Such mixtures can also be used for the protection of the inner surface of concrete-lined, or of wood or metal, tanks.

As a final illustration of a special form of the dipping process may be mentioned the production of rubber thread. The latex, preferably concentrated compounded latex, is allowed to flow through a small orifice into a suitable coagulant bath, *e.g.*, acetic acid, or a bath capable of effecting osmotic dehydration and setting, *e.g.*, ammonium acetate, through which it is drawn

continuously to conveyors on which it can be spray-washed, dried, and even vulcanized in a continuous operation. The thread so obtained is of circular cross-section, and in addition to having the special properties associated with latex rubber, can be obtained in very fine "counts" as low as $\frac{1}{125}$th of an inch in diameter. The surface of such thread moreover is smooth, whereas that of ordinary thread which is cut from thin sheet is distinctly rough. Unlike "cut thread" there is also no limit to the length which can be produced continuously.

Moulding.—It is possible of course to use latex indirectly for moulding purposes by conversion either into a dry rubber mixing or into a dry crumb, the latter being possible, for example, by a suitably modified "latex precipitate" process, and then to produce shaped articles either by an ordinary rubber moulding operation or, in the case of crumb, by shaping in a similar type of mould to that used for synthetic resin moulding powders. The articles thus formed can be either of the soft rubber type or ebonite type according to requirements, the main difference being in the proportion of sulphur employed for vulcanization. Moulding of latex by gelation or coagulation to a continuous solid mass in a shaped cavity has two distinct disadvantages, namely, the slowness of complete drying of a wet coagulum of substantial dimensions and the shrinkage which occurs during drying of a coagulum of soft rubber. These disadvantages, however, are obviated and important advantages gained in at least two special cases of this type of moulding. If the latex containing sufficient sulphur is vulcanized to the condition of ebonite in circumstances substantially preventing the loss of the entrained water, the resulting ebonite retains the dimensions of the mould, the water being very finely distributed throughout its mass. On drying, a light-brown microporous ebonite is obtained, the pale colour being due to the discontinuity of the surface; pure ebonite dust also is brown. By selecting the concentration of the original latex, it is possible to produce ebonite with microporosity as high as 80% of the total volume or as low as 15% or less. If it is desired to reduce the microporosity still further, the wet gel can be pressed to remove any predetermined amount of water before vulcanization. For ordinary purposes, however, a convenient proportion of pore space to solid material is of the order of 45% to 55%. To the naked eye such ebonite has a smooth surface; it can be polished. In compression of the dry material darkening results, but application of heat causes recovery of the original structure and colour. Microporous ebonite of this kind probably contains hundreds of thousands of pores per sq. cm. of surface, the diameter of the pores averaging a few ten thousandths of a millimetre. It can be used for filtration purposes, and is particularly applicable in the form of diaphragms for electric batteries and accumulators. Even if the rubber is not vulcanized to a hard condition, the shrinkage of the rubber to a solid mass may not be complete, and it is possible to obtain microporous soft rubber, the practical advantages of which, however, are more limited.

After adding a small proportion of a frothing agent, such as an alkali soap to compounded latex, it is possible to beat this into a froth which by the addition of a coagulant with delayed action, *e.g.*, an aqueous suspension of sodium silicofluoride, can be caused to set or gel after pouring into moulds. The resulting gel constitutes a wet unvulcanized rubber sponge of remarkable uniformity of texture. After vulcanizing the ultra-accelerated froth-gel by immersion of the filled moulds in a bath of hot water the serum and additional water can be removed by squeezing or centrifuging, followed by drying which occurs rapidly. In this way it is possible to produce as single units sponge rubber cushions, arm-rests, back-rests, seats, "squabs," etc. or mattresses of any desired shape, as well as simpler small articles of all kinds, such as household sponges, heel supports, etc. In the older method of production of sponge from dry rubber it was generally necessary to assemble sponge for upholstery by a tedious constructional process from quite small pieces. This new method for making rubber sponge is one of the striking developments in the application of latex. The porosity of the sponge is of a continuous type; the air cells interconnect and thereby provide continuous natural ventilation during use. By lining the mould partially with a continuous film of rubber, *e.g.*, by spraying, sponge rubber aeroplane wheel "fairings" can be made with a smooth non-porous outer surface.

The frothed latex can also be used in other ways, *e.g.*, for dipping purposes so as to produce articles with a soft sponge-rubber covering; it can also be spread, for example, to form a backing for carpets to provide increased softness and resilience. Another striking application is in the preparation of moulds for the production of ornamental cement castings such as are popular in gardens. The pliability of the sponge enables the removal of castings with undercut portions such as are difficult to obtain with any other type of mould. The frothed latex is cast in the first place to produce the necessary matrix and after vulcanization and drying is ready for use.

Mention has already been made of the possibility of moulding seamless hollow goods such as balls and toys by introducing appropriately compounded, concentrated latex into the inside of suitable moulds. Coagulation of the internal latex layer is effected by gentle heat. After removal of the unvulcanized article from the mould it can be dried and, when vulcanized, inflated by means of a hollow needle in the usual way. Any plug which may be necessary finally to seal the article at the point of insertion and withdrawal of the needle can be placed in position before the mould is closed. This process is being operated commercially at the present time.

Application of Latex to the Protection of Metals Etc.

In many of the above processes it will be seen that the latex is deposited initially on a shaped former from which it is subsequently removed. If desired it is also possible to secure the latex in position so as to impart protection of the under-surface against corrosion by the atmosphere or chemical agents, and for this end latex has obvious advantages over rubber sheet which can be applied only to geometrically simple surfaces. If the protective film is to be of ebonite mere vulcanization to

the hard condition alone may impart sufficient firmness of adhesion particularly if the under-surface is of copper or has been copper coated. For the ultimate firm attachment of the latex deposit to metals special compounding ingredients, *e.g.*, hæmoglobin can be helpful, but generally it is advisable to apply a preliminary film of adhesive capable of providing a strong bond between the metal and the rubber. Such adhesives can be applied either as solutions or as emulsions; in the latter case the principles of application, *e.g.*, anodic, ionic, or simple dipping, can be almost identical with those in the use of latex itself. The so-called "thermoprene" type of adhesive obtained by the chemical modification of rubber by heating with sulphonic acids is suitable. It is of interest that an adhesive of this class, *e.g.*, "Vulcabond" can be obtained by the direct action of the agents on latex. The dispersed rubber in latex is in very convenient condition for treatment by hydrolytic agents, *e.g.*, enzymes or alkalis, and it is therefore possible to remove natural protein and other organic non-caoutchouc constituents. Such deproteinized rubber, after washing and addition of waxes, has proved of especial value for purposes of electrical insulation.

In the above discussion of the industrial uses of rubber latex reference has been made particularly to natural latex and its modifications. It must be remembered, however, that artificial "latex" can be produced by the dispersion of rubber (new or even "reclaimed") and that similar processes can be applied to artificial latex and to the natural product. Eventually for certain purposes it may prove economical to ship dry rubber from the plantations with saving in transport costs and to emulsify the product in the home factory to give "latex" of the desired degree of alkalinity and stability. An obvious disadvantage is that the rubber during and possibly also before the emulsification or dispersion process would necessarily be submitted to some degree of milling or mastication with impairment of the strength of the latex rubber. However, a maximum of tensile strength is not always the main requisite.

At one time there was a tendency for prospective users of latex to follow the lines of the ordinary methods of rubber manufacture; it was, for example, frequently suggested as sufficient advantage to mix the latex (either containing its natural proportion of rubber or in a concentrated form) with compounding ingredients of the standard type and then to convert the mixture directly to an unshaped condition for concurrent moulding and vulcanizing by existing works processes. In the light of experience, however, two distinct fields of manufacture can now be discerned for one of which dry rubber still has economic advantages, while latex offers attractive possibilities in the other. An outstanding feature of latex is that it renders possible new lines of manufacture and new methods for which ordinary rubber is unsuited. Some evidence of this has been indicated in the foregoing. Latex indeed is finding application on a very considerable scale in industries which in the past were regarded as quite outside the rubber industry. It is always unsafe to prophesy, but there is a distinct likelihood that the most important lines of development of latex manufactures will be supplementary to rather than competitive with the old-established "heavy" rubber industry.

SOCIETY OF CHEMICAL INDUSTRY

OFFICIAL NOTICE

American Section. Dr. Foster D. Snell, hon. secretary of the Section, has moved both office and laboratory to larger premises at 305, Washington Street, Brooklyn, N.Y., which now becomes his official address for the Society's business.

LONDON SECTION

Some corrections are necessary in the account of Dr. Cecil H. Desch's address to the London Section on May 1 on "Ageing and Age-hardening in Metals," which appeared on pp. 403—404 of the last issue of the JOURNAL. It should be stated in the last paragraph on p. 403 that the diffusion referred to actually occurs before the layers one molecule thick are formed, and is regarded as the first stage of the process. With regard to the hardening of austenitic steels, mentioned in the last paragraph of col. 1, p. 404, it should be stated that the hardening is achieved by the addition of molybdenum or titanium (not a compound), and the extra hardness is obtained without cold working. In the second paragraph on p. 404, col. 2, the opening sentence should read "Replying to points raised, Dr. Desch stated that the difficulties in regard to the use of steels at high pressures were not to be attributed to ageing . . . etc." and in the following two sentences it should be stated with regard to the absorption of nitrogen by cast iron that there is no age-hardening effect, but this does not prevent the surface-hardening which is the object of "nitriding" cast iron.

MONTREAL SECTION

The monthly meeting of the Montreal Section was held on April 6 in the Windsor Hotel. Eighty members attended the dinner and 170 listened to the excellent paper on "The Development of a New Synthetic Rubber," by Dr. Charles M. A. Stine, vice-president of the E.I. du Pont de Nemours & Co., Delaware. Dr. O Maass, chairman of the Section, presided.

In the course of his address, Dr. Stine said:

The underlying motive for all of the early attempts to synthesize rubber was the desire to learn more about the constitution of natural rubber itself. Chemists naturally felt that if they could synthesize rubber in the laboratory they might be able to learn more about its structure. So long as the motive was an academic interest in the structure of rubber, it was natural that the starting material should be either isoprene, *i.e.*, methyl butadiene, identified by Greville Williams in 1860 as the principal product of the dry distillation of rubber, or a closely related hydrocarbon such as butadiene or dimethyl butadiene. No one succeeded in duplicating natural rubber in the laboratory, but when interest in the synthesis of rubber as an academic problem began to wane, a new and even more impelling motive appeared. Between the years 1900 and 1908 the rapid developments in the automobile field created a new and unanticipated drain on the world's rubber resources. Plantation rubber was then only beginning to appear on the market and the supply of wild rubber was incapable of great expansion and the increasing demand drove the price upwards to more than $3·00 per pound. With rubber at such a price, it appeared that

it might be possible to produce synthetically for much less than $3·00 per pound a material that, while not equal to rubber in all respects, would be a satisfactory substitute for it in many of the places where it was used.

Impelled by this new motive, synthetic rubber research went forward at an accelerated rate. In England a corporation was formed for the sole purpose of synthetic rubber research. This corporation is said to have had at one time as many as thirty chemists working on the problem under the direction of no less a distinguished chemist than Sir William Perkin. Their efforts were directed chiefly toward the synthesis of rubber from butadiene, which was to be derived from starch. While these efforts failed to produce a method of rubber synthesis having commercial value, they added a great deal to our fund of knowledge and have served as a guide to subsequent investigators. Sir William and his collaborators apparently defined synthetic rubber in their minds as a polymer of isoprene or of a hydrocarbon closely related to it. There is no record that they gave consideration to the possibility of synthesizing rubber or rubber-like substances from anything but hydrocarbons.

During the world war there was an even more impelling motive for synthetic rubber research, and the energies of a large group of German scientists were directed toward the synthesis of rubber. They succeeded in developing a process that gave a passable substitute for hard rubber, but one which was not a satisfactory substitute for soft vulcanized rubber and since it was no better than rubber for any purpose and many times more expensive, its production ceased immediately the armistice was signed.

A second method of research is illustrated by the course of the Du Pont Company in its efforts to develop synthetically a material with rubberlike properties, but at the same time with some properties differing from natural rubber, since natural rubber had many shortcomings which limit its use industrially. "Du Prene," the synthetic rubber developed from chloroprene, in turn derived from monovinylacetylene, while exhibiting many of the physical properties of natural rubber, in addition exhibits a number of very interesting properties not possessed by isoprene rubber.

Everyone knows that natural rubber has many shortcomings that have limited its use industrially. First and foremost, it is attacked by mineral and vegetable oils which cause it to swell and lose its strength and toughness. It is readily susceptible to oxidation and deterioration under the influence of heat: this shortcoming has been partly overcome by the development of modern rubber antioxidants, but even with the utilization of this development, rubber still deteriorates rapidly enough to make its use for certain purposes impracticable. Rubber is regarded by the layman as being waterproof but it actually absorbs considerable quantities of water when immersed over considerable periods of time, and is by no means impervious to water vapour and other gases. It seemed obvious that if a synthetic material could be produced that did not contain the sugar, proteins and other water-attracting materials found in natural rubber, it would absorb less water. But the big problem was to make an oil-proof rubber and there was every reason to believe that if a starting material could be found that was not a hydrocarbon, but which would polymerize to a rubber-like substance, it would not so readily imbibe crude oil and refined petroleum products. Hence, since the motive for our work was somewhat different from that of those who had previously worked on synthetic rubber, the goal was defined in different terms. Synthetic rubber had not needed necessarily to be a hydrocarbon; in fact, it was preferred that it should not be a hydrocarbon. It needed only to have the conjugated, unsaturated linkages that previous investigators had shown were probably essential for the production of a rubber-like polymer.

Those who had gone before in this quest for synthetic rubber had encountered another serious difficulty that had to be overcome if a synthetic rubber was to be made a commercial reality in times of peace. This was the exceedingly slow polymerization of isoprene and related hydrocarbons and although catalysts have been found that hasten this action to some extent, there is still no practical way of making these hydrocarbons polymerize within a few days. It was thought ideal, therefore, to find not only a compound that would polymerize to produce an oil resistant, rubber-like material, but one that would polymerize many times faster than the then known derivatives of isoprene.

Our efforts did not at first meet with success, but finally a compound was discovered that was chemically closely related to isoprene and had the same conjugated double bond structure; and, fortunately, the change from a non-viscous, colourless liquid to a hard, tough polymer of high molecular weight required only a few days. That starting material is 2-chloro-butadiene, which we have christened "Chloroprene."

Pure chloroprene polymerizes in a few days to a thick viscous liquid, but a small amount of hydroquinone inhibits polymerization. If chloroprene is allowed to polymerize for a few days before adding hydroquinone, and a little methyl alcohol is added, the unpolymerized material is soluble in the alcohol, and a white precipitate of the chloroprene polymer is obtained, which is called "Du Prene."

This polymer is a plastic that is quite similar in its physical properties to natural rubber. Pigments, reinforcing agents, fillers, etc. may be milled into it, just as with natural rubber. It can be sheeted on a calender or extruded through a die and subsequently vulcanized either in a mould or in an atmosphere of steam or hot air without pressure, the same as natural rubber. The only important difference between the vulcanization of "Du Prene" and natural rubber is that "Du Prene" will vulcanize without the addition of sulphur, whereas in order to vulcanize natural rubber it is necessary to add sulphur, selenium, tellurium, or certain organic compounds such as trinitrobenzene. These last compounds are, however, of no commercial importance and practically all rubber that is vulcanized commercially contains sulphur and very occasionally selenium or tellurium in addition.

When "Du Prene" was first produced it was of little practical value because it vulcanized on standing at

room temperatures for a few days, without the addition of any other substance. Fortunately, however, inhibitors of vulcanization such as phenyl-α-naphthylamine and other secondary aromatic amines were found that prevent it from changing further when stored at *room temperatures over a period of a year or more* but nevertheless permit it to be vulcanized at elevated temperatures (120° to 140° C.).

There is a great deal to be said concerning the effect of other ingredients that may be added to "Du Prene" to influence the rate of vulcanization and the properties of the vulcanized product. For example, metallic oxides such as zinc oxide, litharge, and magnesia accelerate the rate of vulcanization and improve the strength and toughness of the vulcanizate. These, however, are details that concern chiefly the rubber chemist. It is perhaps enough to say here that the properties of "Du Prene" can be varied over a very wide range by the incorporation of suitable ingredients. Most of the common rubber compounding ingredients such as zinc oxide and carbon black find an important place in "Du Prene" compounding. Vulcanized products from "Du Prene" may be as soft and extensible as a rubber band or as hard and tough as a solid truck tyre. The nature of the compounding ingredients used depends, of course, on the conditions of service to which the article is to be subjected. For example, an acid-soluble ingredient such as whiting would not be used in a "Du Prene" compound that is intended to withstand strong acids or, to take another example, glue, which is a valuable ingredient in oil-resisting "Du Prene" compounds, would not be used in a "Du Prene" compound that is likely to be immersed in water for considerable periods of time.

"Du Prene" Latex.—Within recent years natural rubber latex has found a great many important industrial uses and the consumption of rubber as latex is still expanding with great rapidity. A synthetic latex that looks just like natural rubber latex can easily be made from chloroprene merely by emulsifying the liquid chloroprene in a dilute soap solution or in water containing some other protective agent and allowing it to polymerize in emulsion form; this synthetic product is called "Du Prene Latex." It differs from natural rubber latex in one important respect, and that is that the rubber particles in it are completely vulcanized. If spread out on a smooth surface and allowed to dry or if impregnated into a porous body and the water removed, there remains a film or deposit of fully vulcanized synthetic rubber.

As would be expected from its chemical composition, "Du Prene" is much less affected by mineral oils and all hydrocarbon substances than is natural rubber. "Du Prene" is only about one-third as permeable to hydrogen, helium, and most other gases as natural rubber and the vulcanized product is much less subject to deterioration through oxidation than vulcanized natural rubber. It is also less affected by heat and the deterioration is of an entirely different sort. Continued exposure to high temperatures (200° F. and over) softens natural rubber, the rate and extent of the softening depending on the vulcanizing ingredients used, and may cause it to revert to the unvulcanized state. "Du Prene" is slowly hardened by exposure to high temperatures and never undergoes reversion. Hundreds of applications for "Du Prene" immediately occur to the manufacturer and consumer of rubber goods, once its properties are known.

When acetylene is passed through the cuprous chloride-ammonium chloride catalyst, not only monovinylacetylene, from which "Du Prene" is made but also divinylacetylene is obtained, and fortunately the conditions of the reaction can be so controlled as to obtain a very high yield of the former and an exceedingly low yield of the latter, or *vice versa*. When divinylacetylene is heated for several hours at approximately its boiling point (85° C.) it polymerizes to a viscous, non-volatile oil, which is called "Synthetic Drying Oil" or "S.D.O."

The lesson to be learned from the story of the synthesis of "Du Prene" is that when we have a sufficient understanding of the physical and chemical structure of complex organic compounds to be able to correlate structure with properties, it becomes possible to approach the question of the synthesis of new products in the laboratory from a point of view which is radically different from that which has usually characterized chemical research involving organic synthesis. One can lay down specifications and, it might be said, blueprint the plan for the finished compound.

In the discussion which followed, Messrs. N. Holland, B. Prince, L. A. de Savoye, Dr. J. B. Phillips, and Mr. Blakeley took part.

Dr. G. B Whitby paid tribute to the excellence of the product produced, and also commented on its uses. Dr. Whitby also dwelt on the wonderful work which has been accomplished under the speaker's guidance and moved a vote of thanks to the speaker for the very fine presentation of his paper.

OTTAWA SECTION

On Thursday, April 20, the members of the Ottawa Section met in the auditorium of the Forest Products Laboratories, Ottawa, to hear an interesting address by Dr. C. Greaves, of the Forest Products Laboratories staff, on "Wood Preservatives." Mr. Ross E. Gilmore, chairman of the Section, occupied the chair. Prior to the main feature of the meeting, Mr. R. D. Whitmore, in giving information about the Canadian Chemical Convention to be held in Quebec City in June, announced that Mr. J. Davidson Pratt, who would be in Canada at that time, would give an address on the progress of British chemistry. The practice of reviewing new books was revived by Mr. A. L. Davidson.

The speaker remarked in opening that his field was a wide one, commensurate with man's many uses for wood and his desire to make his handiwork as permanent as possible. Strangely enough, the earliest preservatives were still regarded as the best, both as regards cost and permanence, which was perhaps a reflexion on modern investigation.

Preservation was designed to prevent deterioration from decay, from insect attack, such as the marine borer, from fungoidal attack, from mechanical abrasion and from fire. Taking the last first, wood could be protected from fire by treatment with a solution of di-ammonium phosphate, but the process was costly. Decay was

due mainly to organisms and fungi. Fungi spread by means of spores which falling on wood produced mycelia that drew upon the host for sustenance, and were also propagated by contiguity of an infected piece and a sound log. The removal of necessary features in the environment inhibited the development of such organisms.

The necessary properties of a wood preservative were (1) toxicity to fungi; (2) cheapness and ready availability; (3) ease of application; (4) its use should not increase the fire hazard; (5) its use should not impair the appearance of the wood; and (6) its use should not prevent surface from taking paint easily. The best preservatives were liquids, either organic, such as creosote, or inorganic solutions, the best of which were zinc chloride, mercuric chloride, copper sulphate, and sodium fluoride. In Canada, creosote was practically the only substance used. Its oleaginous nature increased resistance to wear and tear; it was toxic to vegetable life; it was not difficult to inject into the fibres of the wood, but it was neither a fire retarder nor was the treated wood attractive in appearance. The method of application was to place the wood in a cylinder, to remove the air, to let in the creosote without destroying the vacuum and finally to drive it into the interstices by means of pressure amounting to 100 to 150 lb. per sq. in. The industry had its origin about 1800 when the British Admiralty were concerned about the rapid deterioration of oaken beams in warships. Great stimulus was given some years later and about 1840 patents were taken out for the use of creosote, and the chlorides of zinc, copper, and mercury. After a century creosote was still considered the best and zinc chloride a good second.

The one efficient test for a wood preservative was the test of service but unfortunately this took from 15 to 40 years to carry out. There were however some fairly adequate substitutes, such as the toxic test carried out on malt agar by which the toxic limit could be ascertained. The test took about 4 weeks and gave reliable results if the strain used was always from the same source. Another toxic test was carried out on the wood itself by determining the loss in weight on the dried wood after 3 to 4 months' exposure to fungus.

Creosote varied considerably in composition with the source and the manner of production. It could be obtained from wood or from coal tar, from a gas oven or from a coke oven. High-temperature distillation (about 270°) yielded a large proportion of higher hydrocarbons: low temperature (210°) gave more paraffin hydrocarbons, phenols, and tar acids; there was less tendency to cracking.

Each country had its own specifications for creosote, but the important points were the fractional distillation requirements and the stipulation that the article should be produced from genuine tar without adulteration.

Discussing the theory underlying the process, Dr. Greaves laid down these points: (1) All substances to be toxic, must be soluble in water or readily brought into a soluble state by enzymic action; (2) A saturated solution in water must exceed the toxic limit; (3) Increase in molecular weight means an increase in toxic value but this is offset by the fact that increase in molecular weight involves a reduced solubility in water. At a definite point equilibrium is reached; (4) Phenols of equal molecular weight are not as toxic as hydrocarbons; (5) Paraffin hydrocarbons are toxic but their low solubility tends to detract from their efficiency.

Two films were then thrown on the screen by Mr. J. Rigby and described by Mr. J. F. Harkom. These were placed at the disposal of the lecturer by the Canada Creosote Company and illustrated the commercial process of creosoting railway sleepers and telegraph poles.

A discussion followed in which emerged several points of interest. An absolutely bone-dry state was not essential for the best results; a little moisture did not interfere with the creosoting process, which was carried out at 180 to 200° F. Zinc chloride was applied at 180°. The old custom of charring did not improve conditions, as the logs were made brittle but creosote spraying over the charring had much to recommend it. The U.S. specification did not mention tar acid content but in Germany and England 5%—15% was required. Bacteria did not play a large part in wood deterioration. The dipping of wooden seed labels in a solution of copper sulphate increased their life from one to five years, deterioration taking place chiefly at the surface of the ground.

On the motion of Mr. F. J. Hambly, seconded by Dr. Shutt, a vote of thanks was enthusiastically tendered to the speaker, and to Messrs. Rigby and Harkom.

CHEMICAL SOCIETY

Forty-two new Fellows were elected at the ordinary scientific meeting held on May 4. The president, Prof. G. T. Morgan, O.B.E., F.R.S., who occupied the chair, announced the composition of the Finance and General Purposes, Library, Publication, and Research Fund Committees for 1933—1934.

Dr. E. B. Maxted discussed:

The Energetics of Catalysis. Part I. The Energetic Homogeneity of a Platinum Surface. [With G. J. Lewis.]

The paper contains an attempt to analyse the distribution of energy within a catalytic surface by investigating the variation in the energy of activation from point to point. Platinum black was progressively poisoned by mercury ions; and, from its activity, at various stages of poisoning, for the decomposition of hydrogen peroxide at 0°, 15°, and 25°, the energy of activation was measured, firstly, for the unpoisoned surface and, subsequently, for the gradually decreasing residual fraction left by progressively occupying the surface by increasing concentrations of the poison. This energy was found to be independent of the stage of poisoning and to have the same value both for the unpoisoned and for the partly poisoned platinum. The surface of such a catalyst is therefore energetically homogeneous in the above sense.

In reply to Prof. G. I. Finch, who also remarked that he had found a crystalline structure to be essential for

catalytic activity, Dr. Maxted said that by a "homogeneous surface" he meant in this instance one having at all points the same energy of activation.

Dr. E. D. Hughes discussed :

Influence of Poles and Polar Linkings on the Course pursued by Elimination Reactions. Part XV. Dynamics of the Elimination of Olefins from Quaternary Ammonium Compounds. [With C. K. Ingold.]

The decomposition of β-phenylethyltrimethylammonium hydroxide is bimolecular and has first order dependence on each of the participating ions. That of β-*p*-nitrophenylethyltrimethylammonium iodide is, however, unimolecular, and is independent of the presence of iodides and other neutral salts. Reaction is retarded by acids but accelerated by bases ; and it is retarded by replacing solvent water with *n*-propyl alcohol. In aqueous solution, the velocity constant for the decomposition of β-*p*-nitrophenylethyltrimethylammonium bromide is the same as that of the reaction of the corresponding iodide.

Influence of Poles and Polar Linkings on the Course pursued by Elimination Reactions. Part XVI. Mechanism of the Thermal Decomposition of Quaternary Ammonium Compounds. [With C. K. Ingold, and C. S. Patel.]

Data on this subject, which have been recorded since the appearance of Part I (1927), are summarised and correlated on the principle that the elimination either of olefin or alcohol may pass over from a unimolecular to a bimolecular mechanism and *vice versa* on the introduction of appropriate constitutional conditions, the nature of which is considered. Von Braun's conception of alcohol elimination is criticised.

Prof. C. K. Ingold added that the views described were regarded as applying to aliphatic substitution in general, and suggested that even saturated carbon could provide valency for the formation of a critical complex prior to substitution.

Dr. L. Hey discussed :

Influence of Poles and Polar Linkings on the Course pursued by Elimination Reactions. Part XVII. Thermal Decomposition of Phosphonium Ethoxides. [With C. K. Ingold.]

Tetramethylphosphonium ethoxide yields trimethylphosphine oxide and propane. Tetraethylphosphonium decomposes similarly giving butane but no ethylene. The main products from β-phenylethyltriethylphosphonium ethoxide were butylbenzene and triethylphosphine oxide, but styrene and triethylphosphine were also formed. ββ-Diphenylethyltriethylphosphonium ethoxide gave diphenylbutane and triethylphosphine oxide in small proportion only, the main products being diphenylethylene and triethylphosphine. These results are discussed in relation to the mechanism advanced in Part V for the decomposition of phosphonium hydroxides.

Dr. E. H. Farmer asked how the thermal decomposition had been carried out.

Prof. Ingold referred to early work on the subject by Collie, and the president recalled investigations by Pickard and Kenyon.

Dr. Hey replied that the phosphonium halides were converted into ethoxides by the addition of the equivalent of NaOEt in Ca-dried alcohol, and the alcoholic solutions of the phosphonium ethoxides were distilled in a slow stream of nitrogen. In each case decomposition began at about 100—120°, and was completed at about 140° (bath temperature). The residual phosphine oxides were identified by b.p. and m.p. and by conversion into trichloroacetate or chromate. Any phosphine in the alcoholic distillate was identified by conversion into quaternary phosphonium halide and thence into picrate. Unsaturated products were collected in, or treated with, bromine and identified as dibromides. Gaseous products were collected in an aspirator and analysed in a Bone–Wheeler apparatus.

Prof. S. Sugden discussed :

The Dielectric Constants of some Organic Liquids

A simple resonance method is described, and the errors due to cell and circuit discussed. The following corrected dielectric constants are found : benzene 2·272 ± 0·001, chlorobenzene 5·612 ± 0·006, ethylene dichloride 10·36 ± 0·02, acetophenone 17·39 ± 0·02, benzonitrile 25·19 ± 0·04, nitrobenzene 34·75 ± 0·07. The dielectric constant of all six liquids was found to be independent of frequency up to frequencies of 1600 kilocycles per sec.

Dr. E. H. Farmer asked whether the presence of moisture greatly affected the results.

Mr. N. J. H. Wallis said that benzene dried with sodium gives results different from those obtained with benzene dried over phosphorus pentoxide.

Prof. Sugden said that the error of measurement was not greater than 1 in 1000, but one of the chief difficulties was to get thoroughly dry liquids. The mean deviations corresponded to about 1 in 500. The presence of moisture caused appreciable differences. Phosphorus pentoxide dries benzene instantaneously, whereas with sodium the process is slow.

BIOCHEMICAL SOCIETY

The 154th meeting of the Biochemical Society was held in the Biochemical Laboratory, Cambridge, on Saturday, May 6, when the following papers were read :

"The Chemical Nature of the Active Group in the Enzyme Glucose Dehydrogenase," by D. C. Harrison. It has previously been shown that glucose dehydrogenase, an enzyme from liver, oxidises glucose to *d*-gluconic acid. It is found that this oxidation is completely inhibited by the addition of the Schardinger (or xanthine) oxidase from milk. This inhibition has been found to be due to an irreversible, oxidative destruction of glucose dehydrogenase by the milk enzyme. Since the Schardinger or xanthine oxidase oxidises only aldehydes and certain purines, it is inferred that glucose dehydrogenase contains either an aldehyde or purine group. A reversible inhibition of the activity of the dehydrogenase is brought about (in slightly acid but not in slightly alkaline solution) by the aldehyde-reagent sodium bisulphite even in concentration of M/1000. It is deduced that the activity of glucose dehydrogenase is associated with the presence of an aldehyde group in the enzyme.

"A Chemical Difference between Antirachitic Factors from Different Sources," by S. K. Kon and R. G. Booth. Autumn and winter butter either saponified in the usual

ay by refluxing for one hour on the water bath with lcoholic potash or subjected to "cold" saponification, ses a large part (over 80%) of its antirachitic potency s estimated by prophylactic experiments on rats. nder exactly similar conditions irradiated ergosterol The International Standard of Vitamin-*D*) and cod ver oil could be subjected to saponification either alone r mixed with butter without loss of potency. Preliminary experiments seem to indicate that the antirachitic factor present in summer butter is more stable han that found in winter and autumn butter. Detailed xperiments on this point and also with butter from ows receiving large amounts of irradiated yeast are ow in progress. The fact that the stability to saponification of the antirachitic factor of cod liver oil and of radiated ergosterol is not adversely influenced by the resence of butter speaks against the existence in butter f a specific destructive factor and in favour of a true hemical difference between the antirachitic factor of utter and those of cod liver oil and irradiated ergosterol. vidence is at present accumulating from various aboratories in favour of the existence of a biological ifference between the antirachitic factor of cod liver il and irradiated ergosterol, and it is suggested that t least three separate antirachitic agents are distinuishable at present: (1) Irradiated ergosterol; (2) he biologically different antirachitic factor of cod liver il; (3) the antirachitic factor of butter chemically ifferent from (1) and (2).

"The Antiglyoxalase Action of Pancreatic Extracts, nd Related Experiments on the Inhibition of Glycolysis Muscle Extracts," by S. Ochoa and H. W. Dudley. he inhibition of the enzymic formation of mandelic cid from phenylglyoxal, and of lactic acid from methylyoxal by pancreatic extracts has been studied. The esponsible agent (or agents) in the pancreatic preparaions used was almost completely precipitated by hosphotungstic acid, from which it could be regenerated.

The effect of the "hexone bases" was therefore xamined, and it was found that histidine displayed a ypical antiglyoxalase action, that of arginine and lysine eing much weaker.

The antiglyoxalase action of histidine is partly due o its ability to remove the substrate by combining ith it chemically, but it also exerts a direct inhibitory ction on the enzyme system itself. The formation f lactic acid from glycogen by muscle extracts is also nhibited by histidine.

"A Comparison of the Choline-esterase Activities of he Blood Sera from Various Species," by E. Stedman, llen Stedman, and A. C. White. It has recently been hown by Stedman, Stedman, and Easson that while ver-esterase has no action on esters of choline, there xists in the blood serum of the horse an enzyme which ydrolyses such esters but nevertheless has little or no ction on simple esters such as methyl butyrate. This nzyme has been termed choline-esterase. The blood era from a number of animals have now been examined or choline-esterase and esterase activities. The results an be roughly classified as follows:—*High choline-esterase and little or no esterase activity:* man, monkey, og, fox; *high choline-esterase and some esterase activity:* orse, guinea-pig, cat; *small choline-esterase and little or no esterase activity:* pig, fowl; *no choline-esterase and small esterase activity:* rat, rabbit; *little or no choline-esterase and high esterase activity:* pigeon, goose, duck, tortoise, mouse; *neither choline-esterase nor esterase activity:* sheep, goat, ox, ferret, hedgehog. The activities of the sera towards tributyrin have also been examined and the results indicate that such activity is probably mainly due to the presence of a third enzyme.

The choline-esterase content of human serum varies considerably in different individuals.

"Phenyl *Iso*cyanate Protein Compounds and their Immunological Properties. II. The Gelatin Compounds," by S. J. Hopkins and A. Wormall. Further chemical and immunological studies have been made on phenylureido-proteins prepared by a method described in a previous communication. Gelatin reacts with phenyl- and *p*-bromphenyl-*iso*cyanates to give compounds which can be precipitated by antisera to phenylureido horse-serum-globulin, but immunization experiments, in which phenylureido- and *p*-bromphenylureido-gelatin have been injected into rabbits, indicate that these compounds are not antigenic. Thus the non-antigenicity of gelatin does not appear to be due solely to the absence of aromatic groupings. Inhibition tests, involving the addition of various phenylureido- and *p*-bromphenylureido- amino-acid compounds to mixtures of phenylureido-gelatin and antibodies to phenylureido-horse-serum-globulin, confirm the view that the isocyanate reacts with the free amino groups of the lysine molecules of the protein.

"Metabolism of the Avian Yolk-Sac," by J. Needham (introduced by Mrs. D. Needham).

"The Anærobic Decomposition of 1-Cystine by Washed Cells of *Proteus vulgaris*," by H. L. A. Tarr. Previous investigators have studied the formation of such volatile sulphur compounds as hydrogen sulphide, ethyl mercaptan and diethylsulphide arising from the bacterial decomposition of cystine. In contrast with this the present work has led to the establishment of a complete "balance sheet" for this amino acid by the use of a technique employing washed cells of *P. vulgaris*. Relatively large amounts of cystine are decomposed quantitatively in 24 hours at 37° under anærobic conditions, and adequate evidence has been obtained in support of the following manner of breakdown:

$$CH_2SH{\cdot}CHNH_2{\cdot}COOH + 2H_2O \rightarrow H_2S + NH_3 + CH_3{\cdot}COOH + H{\cdot}COOH$$
$$H{\cdot}COOH \downarrow H_2 + CO_2$$

"A Method of Comparing the Catatorulin Potency of Crystalline Vitamin-B_1 Preparations," by R. Passmore, R. A. Peters, and H. M. Sinclair.

"Notes on the Ultra-Violet Absorption of the Fatty Acids of Cod-Liver oil," by W. J. Dann and T. Moore. Engelberg's Norwegian cod-liver oil was saponified by boiling for 1 minute with alcoholic potash. After dilution of the soaps with water the unsaponifiable matter was separated by extracting 4 times with ether, the free acids were then obtained by acidification of the soaps using 10% sulphuric acid, followed by ether extraction. $E^{1\%}_{1cm.}$ at 230 mμ for the free acids was only 7·6, as opposed to the value of about 180 found for the cod-liver

oil acids by previous workers. On refluxing the acids with excess of alcoholic KOH however, $E^{1\%}_{1cm}$ 230 mμ rose steadily, reaching the value of 39 after 4½ hours, 72 after 12 hours. The unsaponifiable fraction, which *amounted to 13%, also showed a slight increase in ab*sorptive power when subjected to 4 hours, refluxing with alcoholic KOH, $E^{1\%}_{1cm}$ at 328 mμ rising from 62 to 69, at 260 mμ from 17 to 34, at 230 mμ from 38 to 55. No significant loss in weight in the unsaponifiable fraction after refluxing could be detected and it is *improbable* that more than *traces* of acid decomposition products were formed. The absorption due to the unsaponifiable fraction would represent only a negligible *proportion of the absorption at 230 mμ given by the* acids and unsaponifiable matter if examined without separation.

"A New Hormone of Intermediate Metabolism Isolated from Normal Urine," by Casimir Funk. Anselmino and Hoffman have reported upon the isolation of a hormone from anterior pituitary and urine of pregnancy, which they termed fat metabolism hormone and which injected into rats causes an increase of acetone and especially β-oxy-butyric acid content of the blood. We thought at first to be dealing with the hormone of Anselmino and Hoffmann, but gradually it became evident that we isolated a new substance. This new and important hormone is found in appreciable quantities in every urine and its preparation has already been described. When injected into animals it causes the formation in the blood of a volatile intermediate product, which combines with iodine, and which apparently is neither acetone, nor acetaldehyde. The blood *in vivo* and *in vitro* shows a diminution of this volatile substance with gradual acidification. The action of the hormone is not influenced by insulin and therefore we are not dealing here with an acidosis in a strict sense. The intermediate products have not been yet identified, but we are dealing probably with an aldehyde-acid transformation.

SOCIETY OF GLASS TECHNOLOGY

The 16th annual general meeting of the Society of Glass Technology was held in Sheffield on Wednesday, April 12, 1933. Mr. G. V. Evers (of Messrs. E. J. & J. Pearson, Ltd., Stourbridge) was elected president, in succession to Mr. Edward Meigh, M.B.E., M.Sc.

At the ordinary general meeting which followed, a lecture entitled "Notes on Toughened Plate Glass" was given by Mr. James Meikle of Messrs. Pilkington Bros., Ltd., St. Helens.

Mr. Meikle explained that "Armourplate" was the trade name given to plate glass which had been subjected to a special toughening process by which it was endowed with strength far in excess of that of the ordinary plate glass and moreover, when broken, shattered in small, comparatively harmless fragments. Glass made on the Continent, and having the same properties, was known as "Securit," while a safety glass used for motor vehicles was known as "Triplex Toughened."

The method of manufacture of "Armourplate" was based on the principle of heating uniformly and then suddenly chilling by cold air. For successful toughening the physical conditions of the process had to be controlled within very fine limits. The process could be applied to plate within wide limits of thickness and superficial area. There were technical difficulties in toughening glass thinner than $\frac{3}{16}$ in., but above this there was no difficulty with glass up to 1¼ in.

The character of "Armourplate" was described, it being compared with a sandwich in which there were two outside layers in compression separated by a layer in tension.

The strength of "Armourplate" in resisting bending under load was discussed and demonstrated. In impact tests performed by dropping a steel ball on to sheets of plate and of "Armourplate" glass supported near the ends, the height from which the ball was required to drop in order to fracture ¼-in. "Armourplate" was of the order of seven times that necessary to break the ordinary plate glass.

Tests devised to show how "Armourplate" retained its properties were described. In no case did the glass deteriorate. A fatigue test consisted of twisting a piece of the glass, measuring 45 in. × 10 in. through an angle of 12° in each direction, at the rate of 750 reversals per minute up to a maximum of *100,000* reversals without fracture. One piece of ordinary plate of the same size was broken with one twist of 10° and another with one twist of 8·5°.

The lecturer stated, in conclusion, that the conditions in "Armourplate" glass which predetermine the size of the fragments on breakage were not fully understood and he invited expressions of opinion on this point.

Two cinema films were then shown illustrating the manufacture and properties of plate and "Armourplate" glass.

SOCIETY OF PUBLIC ANALYSTS

An ordinary meeting of the Society of Public Analysts was held at the Chemical Society's Rooms, Burlington House, on Wednesday, May 3, with the president, Mr. F. W. F. Arnaud, in the chair.

Certificates were read in favour of L. H. James and *Arthur Jones. The following were elected members*: G. V. Hall, G. Holland, H. S. Howes, F. W. Moore Jaffé, and M. McFarlane Love.

The following papers were read and discussed:

"An Investigation of Solanine Poisoning," by S. G. Willimott, Ph.D. In two districts of Cyprus there is a practice of eating potato shoots and leaves as vegetables, and last year an epidemic of poisoning was traced to this cause. The author describes the symptoms in one of the cases, and gives an account of the tests used to identify solanine in the food. It was found that the solanine content of potato shoots diminishes as the altitude at which the plant is grown increases. It is suggested that habitual consumers of potato shoots acquire an immunity from the toxic effects of the alkaloid.

"The Examination of Leather for the Presence of Extractable Chromium Compounds," by F. E. Humphreys, Ph.D., and H. Phillips, D.Sc. In view of the fact that cases of dermatitis have been attributed to the wearing of chrome-tanned leather, experiments have

n made to ascertain the amounts of chromium ıpounds which can be extracted from various types of ›me leather, under conditions similar to those which leather encounters during wear. The results showed t chrome leathers suspected of causing dermatitis not contain a greater quantity of water-extractable ›mium than did normal leather, and it is suggested t. whilst none of these leathers would irritate the skin an average person, many chrome leathers might tate the skin of a person particularly sensitive to the ion of chromium compounds. Analogous experiments ›ved that solutions resembling sweat in composition not remove much more chromium, either in the m of chromate or trivalent chromium compounds, ın does water, although slightly acid solutions tend extract slightly larger amounts than neutral solutions.

" Barium as a Normal Constituent of Brazil Nuts," W. M. Seaber, B.Sc. Barium occurs as a normal nstituent of Brazil nuts, the amounts found in 14 nples of the shelled nut of different seasons ranging ›m 0·02 to 0·31%. Nearly the whole of the barium is an insoluble form, but a considerable proportion of it n be extracted by 0·15% hydrochloric acid, and ith higher concentrations of acid it is practically l dissolved.

' The Phytosteryl Acetate Test as a Routine Method r Examining Butter Fats," by Herbert Hawley. method is described in which the sterols are directly ktracted from a small amount of butter fat by shaking ith chloroform and an alcoholic solution of digitonin, nd then converted into acetates the melting point of hich is determined. The method will detect 5% of egetable fat in butter or ghee. A special form of pparatus has been devised for the extraction.

PERSONAL AND OTHER ITEMS

Mr. Alan Chorlton, C.B.E., M.P. (President of the nstitution of Mechanical Engineers) and Dr. F. S. innatt, M.B.E. (Director of Fuel Research) have been ppointed to represent H.M. Government as official lelegates at the Sectional Meeting of the World Power onference to be held in Sweden, Denmark, and Norway, etween June 26 and July 8, 1933.

We regret to announce the death on April 15 of Dr. . W. Drummond, one of the Society's oldest members n America. Dr. Drummond was chairman and chemist of the Devoe & Reynolds Co., paint and varnish manufacturers of New York, positions which he held from 1880 until his retirement a few years ago. He joined the Society in 1898, and was a member also of several other scientific societies in America.

We regret to learn of the death in Detroit, on April 5, of Mr. Niels C. Ortved, who was for twenty-one years a Canadian member of the Society. Mr. Ortved, who was born in Denmark and studied chemistry at the University of Copenhagen, went to America at the beginning of the century, and worked in several large distilleries before becoming chief chemist of Hiram Walker & Sons, of Ontario, a position he held for more than 20 years. He took an active part in the affairs of the American Chemical Society, and was president of its Detroit Section in 1913—14.

Prof. Fritz Haber has notified the Prussian Minister for Education of his decision to retire from the position of director of the Kaiser Wilhelm Institute of Chemistry at Berlin, and from the Chair of Chemistry at Berlin University. Prof. Haber is famous throughout the world as a Nobel Prize winner, and the originator of the Haber process for the fixation of atmospheric nitrogen in the form of ammonia, a process which was of great value to Germany during the war, and has since benefited agriculture in many countries. His resignation follows those of Profs. Polanyi and Freundlich from the staff of the Kaiser Wilhelm Institute, and coincides with the many changes in the German Universities recently brought about by the Prussian Minister of Education, Dr. Rust, in reducing the numbers of Jewish professors.

The Harvard Corporation has chosen Dr. James B. Conant to be president of the University in succession to Dr. A. L. Lowell, who resigned recently. Prof. Conant, who is 40 years old and one of the youngest persons ever to hold the position, has been a student and teacher at Harvard University since 1910. He is professor of organic chemistry and has been chairman of the Chemistry Division of the University for the last two years.

Chemical Society: Announcements

The president, Prof. G. T. Morgan, O.B.E., F.R.S., will preside over the discussion, to be held on May 12, from 4 to 6 p.m. and from 8 to 10 p.m. in the Chemical Department of the University of Leeds, on " Substitution in Aromatic Systems." Papers will be communicated by Prof. R. Robinson (in whose unavoidable absence from the early meeting the contribution will be read by Dr. J. C. Smith), Prof. G. M. Bennett, Dr. C. W. Shoppee, Prof. C. K. Ingold, Dr. J. W. Baker, and Prof. H. M. Dawson.

The sixth Hugo Müller lecture, entitled " Chemistry at the Cross Roads," will be delivered by Prof. H. E. Armstrong, F.R.S., in the meeting hall of the Institution of Mechanical Engineers, S.W.1, on May 25, at 5.30 p.m.

The next meeting of the Research Fund Committee will be held in December, 1933; no grants will be allotted in June.

British Association Meeting

The British Association will hold its annual meeting this year, under the presidency of Sir Gowland Hopkins, at Leicester from September 6 to 13. This is the second time the Association has held its meeting in Leicester, the first occasion being in 1907. The preliminary programme of the meeting, just issued, states that the inaugural meeting will be held on September 6 in the De Montfort Hall, when the president will give an address on " Chemical Aspects of Life." Prof. R. Robinson is the president of the Chemistry Section, and his address will deal with natural colouring matters and their analogues. In the Engineering Section Mr. R. W. Allen's presidential address will deal with some experiences in mechanical engineering, and Prof. W. G. Fearnside, as president of the Geology Section, will speak on the structure of some British coalfields. Dr. A. Lauder's presidential address in the Agricultuer Section will be on chemistry and agriculture. Tickets

for the meeting may be obtained from the office of the Association, Burlington House, Piccadilly, W.1. It is announced that the 1934 meeting will be held in Aberdeen.

Centenary of Zürich University

Among the visiting chemists present at the recent centenary celebrations of the University of Zürich (April 28 to May 1) were Prof. P. Pfeiffer (pro-Rector of Bonn University), Prof. H. von Euler (Stockholm), Prof. V. Cepinskis (Kaunas, Lithuania), Prof. A. Miolati (Padua), and Prof. J. Read (St. Andrews). Sir H. Miers represented the Royal Society of London. In his opening address, delivered on April 29, the Rector of the University of Zürich (Prof. F. Fleiner) paid a warm tribute to the work of Alfred Werner, formerly professor of chemistry in the University. The recipients of honorary degrees included Prof. P. Karrer, the present professor of chemistry in the University of Zürich, upon whom was bestowed the honorary degree of doctor of medicine in the University of Breslau.

The Third British Glass Convention

Sir Max J. Bonn, K.B.E., will preside over the Third British Glass Convention, which is to be held at Buxton from May 18 to 20. Sir Max is chairman of the United Glass Bottle Manufacturers, Ltd., the largest firm of bottle manufacturers in Europe.

At the Convention, in addition to Sir Max's own address entitled "My Apprenticeship in the Glass Industry, 1926—1933," addresses will be delivered by well-known authorities on such subjects as trade organization work, shorter working hours, recent technical developments abroad, and the influence of education and research in the industry. There is also to be an official luncheon, at which the principal speaker will be the Rt. Hon. J. H. Thomas, P.C., M.P., Secretary of State for the Dominions. On the social side there will be a tennis tournament, a golf competition for the championship of the glass industry, a mayoral reception, and Convention dinner, and two or three dances, together with motor tours to neighbouring beauty spots. Brochures giving the programme in full may be obtained from Mr. G. Marchand, M.A., Norwich House, 13, Southampton Street, High Holborn, London, W.C.1.

Anglo-German Trade Agreement

By the provisions of the trade agreement, dated April 13, 1933, between H.M. Government of the United Kingdom, and the Government of the German Reich, the text of which has recently been published, the following chemicals imported into England from Germany will be subject to reduced import duties: Acetic acid of a strength not exceeding 95%, other than acetic acid which is subject to duty under the Safeguarding of Industries Act, 1921, as amended by the Finance Act, 1926 (33⅓%—reduced to 20%); acetone, other than acetone which is subject to duty under the Safeguarding of Industries Act, 1921, as amended by the Finance Act, 1926 (33⅓%—reduced to 20%); tartaric acid (20%—reduced to 15%); formaldehyde (33⅓%—reduced to 25%). In return for the reduced import duties on these and other articles, the German Government undertakes to issue licences for the importation of a minimum amount of 180,000 metric tons of coal and coke per month. This amount is based upon a consumption of coal and coke in Germany of 7,500,000 metric tons a month; in the event of consumption exceeding this amount a proportionate increase in the importation of English coal is provided for.

Trade Agreement with Denmark

The text has been issued of the agreement between the Governments of the United Kingdom and Denmark, which was signed on April 24, 1933. The agreement, which is binding for a period of three years, is to come into operation immediately following the exchange of ratifications. The agreement accords preferential trade facilities for a number of Danish exports, notably dairy products, bacon, hams, and fish, including also organo-therapeutic preparations (excluding synthetic organic chemicals etc. manufactured by fermentation processes) rennet, and aunatto colouring. In return Denmark has agreed to take 80% of her coal imports from the United Kingdom (as compared with 53% in 1932) and provides tariff concessions to a wide range of English goods. Tartar, copper sulphate, asphalt, iron, steel, and steel mesh are amongst the products which will enter Denmark duty-free, whilst piece-goods, paints and colours, photographic plates, and motor vehicles will be imported into Denmark at preferential tariff rates.

German Applied Physical Chemistry Convention

The annual convention of the Deutsche Bunsen-Gesellschaft für Angewandte Physikalische Chemie E.V. is to be held this year at Karlsruhe from May 25 to 28. The programme for the meeting is an attractive one, and includes addresses by P. Debye, H. Ulich, G. v. Hevesy, C. Tubandt aud A. v. Hippel, and on the concluding day there is to be a drive through the Black Forest to Baden-Baden. Full particulars can be obtained from Prof. W. Bachmann, of the above society, Seelze 197 bei Hannover.

Joint Meetings in Australia

It is of considerable interest to note that the desire amongst chemists for the closer co-operation of societies is not confined to this country. A meeting of the four chemical societies of Sydney was recently held under the auspices of the Australian Chemical Institute to consider holding joint meetings during 1933, and two such meetings are to take place in June and October.

Design in Industry

Arrangements have been made to hold a public exhibition of works sent in for this year's competition of Industrial Designs, organized by the Royal Society of Arts. All the prize and accepted entries will be exhibited in the Exhibition Pavilion of the Imperial Institute, South Kensington, from August 5 to 31.

World Production of Aluminium

According to figures quoted in *Die Chemische Industrie* (Mar. 25, 226) the world production of aluminium in 1932 was 152,795 tons, compared with 230,433 t. in 1931. The following figures give the productions in tons of separate countries for the two years: Germany 13,765 (26,750); U.S.A., 47,575 (80,553); Canada, 17,800 (30,950); France, 14,110 (24,400); Switzerland, 13,820 (16,000); Norway, 19,590 (21,300); Italy, 13,200 (11,500); Austria, 3200 (3000).

REVIEWS

CLUES AND CRIME: THE SCIENCE OF CRIMINAL INVESTIGATION. By H. T. F. Rhodes. Pp. ix + 283. London: J. Murray, 1933. 6s.

Mr. Henry Rhodes' latest book is a most valuable contribution to the literature of criminology. Every page bears evidence of careful research, and the author obviously knows his subject extremely well.

Mr. Rhodes is of course well known to readers of this JOURNAL as Editor of the *Chemical Practitioner*, but it may not be so widely known however that he is also a member of the International Academy of Criminology and has broadcast talks from London on the subject of crime.

"Clues and Crime" deals with the science of criminal investigation. Commencing with the 17th century, the author presents the reader with an array of criminal cases in which the adoption of scientific methods has been the chief factor in tracing the criminal. It is refreshing to find that the majority of cases described are by no means the usual "classics," but are unfamiliar crimes taken from many sources. Of particular interest are the author's comments upon the Vera Page murder, which he says "is remarkable for the amount of information which was extracted from such apparently insignificant material."

The contents include chapters on Traces and Stains, Forgery, and Camera and Microscope. They are a remarkable tribute to the aid which chemistry renders in the detection of crime, though it is perhaps somewhat disturbing to realize that expert witnesses can usually furnish as convincing a case for the defence as for the prosecution, and that the sifting of this conflicting testimony rests with twelve laymen.

The book contains some interesting illustrations, is written in an extremely readable style and amply bears out the author's hope that it will demonstrate conclusively "that if the history of the application of science to criminal investigation is short, it is at least significant and arresting." V. R. R.

ANTIQUES; THEIR RESTORATION AND PRESERVATION. By A. Lucas, O.B.E., F.I.C. 2nd ed., revised. Pp. 240. London: E. Arnold & Co., 1932. 8s. 6d.

It needs little imagination on the part of the reader to enter into the fascination of this entrancing subject as described by Lucas, who had the unique opportunity of conducting the preservation of perhaps the richest find of Egyptian archæology, the tomb of Tut-ankh-amūn. It is fortunate that the technique of the preservation of museum specimens had already attained a high degree of efficiency when in 1922 the tomb was discovered. The literature of the subject was greatly scattered, however, and, with few exceptions, was beyond the reach of our museum curators. The value of the present work lies in the fact that these papers have been collected and their contents reformulated in the light of practical experience for the benefit of museums and private collections.

In the present edition the work has been revised and largely rewritten, notably the chapter on the application of methods to specific materials. Metals, pictures, plaster, and stone have been dealt with in an exhaustive manner. A similar claim is not made for the sections on bone, leather, papyrus, and woven fabrics, although these have been expanded and improved.

It seems an omission that no reference has been made to the artificial resins, either vinyl acetate or those of the Bakelite type, since the use of these materials in special types of restoration is now well established. The quantity (7 oz.) of lanolin (p. 83) has unfortunately been omitted. The reference (p. 234) Rhousonpoulos should read Rhousopoulos, an error which has persisted from the earlier edition. Where so much of good exists it seems churlish to draw attention to trivialities and the book is certain to be welcomed alike by private collectors and curators of museums. H. J. PLENDERLEITH

CELLULOSE ACETATE: Its Manufacture and Applications. By A. G. Lipscomb, B.Sc. Pp. xii + 308. London: E. Benn, Ltd., 1933. 21s.

This book deals with the acetate section of the rayon industry in a manner not hitherto attempted, and although it covers a wide field it is free from that superficiality often characteristic of books which endeavour to deal but briefly with an extensive subject matter. The first section of the book describes the large scale manufacture and properties of both cellulose acetate and the raw materials from which it is made, full details being given of the plant conditions and tests necessary for the production of a satisfactory product. Next, wet and dry spinning methods receive attention, together with processes for recovering the solvents employed. Subsequently the essential facts relating to the manufacture of acetate rayon woven and knitted materials are described, and methods for dyeing, delustring, printing, and finishing them are dealt with from the practical and theoretical points of view. Immunized cotton and the use of cellulose acetate as a plastic moulding material constitute a useful final chapter.

Among raw materials, cellulose, acetic acid, and acetic anhydride are well described, the account of cellulose being a very helpful study in which the most recent knowledge of the micellar structure of this substance is linked to its properties and conversion products.

In a book of this type the minute details given with regard to the control sheets etc. in cellulose acetate manufacture are perhaps out of place, although many readers prefer to have too much rather than too little information. In the section on laboratory control the author appears to have overlooked the more recent work of the British Cotton Industry Research Association on the measurement of the viscosity of cotton in cuprammonium solution, but the section is otherwise well done and contains much useful information.

In dealing with the processing (dyeing, finishing, etc.) of acetate rayon materials the author outlines the main developments which have taken place during the past twelve years, and the numerous references to patent literature are valuable. This section of the book is however capable of expansion and indeed requires it. It is probably a slip on p. 249 which attributes Celliton dyes to The Society of Chemical Industry in Basle instead of to I. G. Dyestuffs, Ltd. The reviewer knows of no other book which deals with the manufacture

and properties of cellulose acetate in so useful a manner, and believes that it is well worth the attention of both producers and users of this type of rayon. A. J. HALL

BITUMINOUS EMULSIONS FOR USE IN ROAD WORKS. By F. Wilkinson and F. J. Forty, B.Sc. Foreword by Prof. R. G. H. Clements. Pp. 395. London: Contractors' Record, Ltd., 1932. 21s.

The authors in their preface tell us that the prominence which has been given to the use of bituminous road emulsions during the past eight or ten years is due to their independence of weather conditions, the ease with which the emulsions can be applied, the success with which they have been employed, and the satisfactory service they give when properly employed. But, as is well known, not all attempts to use bituminous road emulsions have been successful and the authors think it still "safe to say that even now the large majority of those road engineers using emulsions do not thoroughly understand either their physical properties or methods of manufacture." Presumably, therefore, the present volume is intended to bring a clearer understanding of the many problems involved in this sort of road work to those concerned with the proper care of our highways. On the whole, the authors have discharged their task ably.

In nine chapters they treat of colloid chemistry, the merits of bitumen and allied substances used in road work with the methods of testing these, characteristics of emulsions and emulsifying agents, processes of manufacture, description of emulsion manufacturing works, tests for bituminous emulsions, uses of such emulsions on roadways, advantages and disadvantages of hot and cold emulsions respectively, concluding with a chapter on specifications and costs.

The principal criticism which may be made is that the authors are not very familiar with what may be termed the purely chemical aspects of the subject. This is very apparent in the first chapter dealing with colloid chemistry. Here the authors have made frequent use of Wolfgang Ostwald's book on the subject, but in spite of this they use the terms "colloid" and "colloidal" very indiscriminately. Moreover, a *sol* is in itself a colloidal solution and it is therefore redundant to speak of colloidal *sols* as is done on p. 34 and again on p. 128. The first paragraph on p. 39 is also very confused in its phraseology. If the book calls for a second edition the authors would be well advised to seek the assistance of a chemical colleague to revise thoroughly the purely chemical parts of the book.

A great deal of very useful and hitherto widely scattered information on the materials of road foundations and road surfaces has been brought within the compass of a single volume and for this reason alone the volume under review will be very welcome to a large number of road surveyors and highways engineers. A number of useful specifications and an ample index complete the volume which is singularly free from typographical errors. On p. 45, line 11, the word "dispensed" should read "dispersed," while on p. 132, line 21, "dextin" should read "dextrin," and on p. 38 "an" should be inserted at the beginning of line 5 in the first paragraph. H. M. LANGTON

MANAGEMENT AUDIT. By T. G. Rose. Pp. ix + 47. London: Gee & Co., 1932. 3s. 6d.

This is substantially a paper read before the Institute of Industrial Admiuistration, which contains a suggestion, elaborated in some detail, for the annual audit or examination of the management of a business comparable with the financial audit conducted by the accountants. It is claimed that such an audit would be of material value to the directorate by enabling them to be satisfied in regard to the detailed organization of the company. The paper endeavours to show that principles and rules can be drawn up for what is recognized as sound management, and that the science of management can be clearly stated under certain definite functional responsibilities. Further, after a brief survey of what the examiners will require to know, it is concluded that it is possible to set out a correct method of controlling each of these responsibilities, whatever the detail circumstances of the case may be. The essay goes on to discuss the qualifications of a management auditor.

The reviewer has found it suggestive reading, and believes that many readers will endorse this view. Whereas one is only considered competent to engage in any of the specialized sections of a large business after suitable training, there are many in these branches, as well as outside them, who regard themselves as needing no previous training to undertake the management of the whole concern. Perhaps the perusal of Mr. Rose's paper will bring conviction that this is an erroneous conclusion.

DIE BRENNSTOFFE UND IHRE INDUSTRIEN. By Prof. Dr.-Ing. M. Dolch. Pp. viii + 200. Leipzig: Akademische Verlagages., 1932. Paper, 12·80 rm.; bound 14.50 rm.

This useful book is indicative of the wide activities of the late Dr. Dolch and deals with the application of fuels to various industries. It is divided into six main parts, the first of which is devoted to solid fuels such as wood, peat, brown and bituminous coals, and also to gaseous fuels. This is followed by the principles and processes of combustion in general and contains sufficient theoretical treatment, together with five pages of useful constants. The section concludes with a brief treatment of various fuel using appliances such as boilers, kilns, furnaces, and ovens. Part 3 deals with the various treatments to which fuels are subjected such as drying, powdering, low and high temperature carbonization. The various types of coke ovens, horizontal and vertical retorts, and chambers are also dealt with, although rather briefly, and are followed by particulars of tar removal, ammonia, and general purification. The next section is allotted to the gasification of fuels and various types of producer are discussed leading up to carburetted water-gas and complete gasification. The intermittent and continuous distillation of tar is also described in some detail together with an outline of the Bergius process. Part 5 deals particularly with petroleum, its distillation and cracking, and gives details of the various fractions. There is a short final section on natural gas. The book contains 71 illustrations, together with name and subject indexes. It can be recommended as a concise presentation of fuels and their application. A. M.

COMPANY NEWS

BOOTS PURE DRUG CO., LTD.

It was announced on May 9 that control of the company had returned to this country by the purchase by British interests of 1,000,000 of the 1,125,000 ordinary shares of £1 held by the United Drug Co. of America. The price paid is reported to be £6 15s. per share. In January last, arrangements were made for a similar transfer of shares to a British group comprising Hambros Bank, Philip Hill & Partners, and Erlangers, but the deal was not put into effect as it was considered by the Treasury to come within the embargo on issues, the proceeds of which would be remitted abroad. In this instance the Bank of England is stated to have been fully cognisant of the negotiations and has raised no objections. There is no intention at present of making any alteration in the management of the company.

The preliminary statement of the directors of the company records net profit, subject to audit, of £701,453 for the year ended March 31, 1933. This amount is about £30,000 less than last year's profit. Four interim dividends amounting to 24%, less tax, have already been paid, and a bonus of 1s. per share, equal to 5%, is to be paid to all shareholders registered on May 5, bringing the distribution to the same level as that maintained in the previous three years.

STEWARTS AND LLOYDS, LTD.

At the 43rd annual meeting of the company on May 2, the chairman, Mr. A. C. Macdiarmid, said that in 1932 the company secured a record proportion of the available world tonnage, but owing to the paucity of demand was forced to work at an extremely low level of operation in relation to capacity. The balance sheet showed that the company was in a stronger position than at the beginning of the year. During the last two years the overdraft had been reduced by £734,000 and now stood at £192,000.

With regard to the scheme explained to shareholders in November last for the development of the Northamptonshire iron ore and blast-furnace properties, work on the site was now going forward. It was looked upon as an important stage in the development of the company. In pursuing its policy of avoiding as far as possible uneconomic competition and duplication of plant, the company had arranged with the United Steel Co. for the interchange of views and co-operation in all matters concerned with manufacture and sale of steel. It had been decided to proceed now with the erection of the tube works in Australia in co-operation with the Broken Hill Proprietary Co., Ltd., and this unit designed for Australian conditions would be installed at Newcastle, N.S.W. The Zinc Manufacturing Co. had established itself in the market and was now producing a zinc oxide of high quality. (Financial results, cf. CHEM. & IND., April 28, p. 377.)

E. I. DU PONT DE NEMOURS & CO.

The net income of the company for the first three months of 1933 was $5,480,515, as against $9,689,433 for the same period last year. The amount earned on the common stock is equal to 35 cents per share, as compared with 74 cents per share last year.

MARKET REPORT

This Market Report is compiled from special information received from the manufacturers concerned.

Unless otherwise stated, the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acid, Acetic, 40% tech.—£20 5s. per ton d/d address U.K. in casks.

Acid, Chromic.—11d. per lb., less 2½% d/d U.K.

Acid, Hydrochloric.—Spot, 3s. 9d.—6s. per carboy d/d according to purity, strength, and locality.

Acid, Nitric 80° Tw.—Spot, £18—£25 per ton makers' works, according to district and quality.

Acid, Sulphuric.—Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 60s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.

Ammonia (Anhydrous).—Spot, 10d. per lb. d/d in cylinders.

Ammonium Bichromate.—8d. per lb., d/d U.K.

Bisulphite of Lime.—£6 10s. per ton, f.o.r. London, packages free.

Bleaching Powder, 35/37%.—Spot, £8 15s. per ton d/d station in casks, special terms for contracts.

Borax, Commercial.—Granulated, £15 10s. per ton; Powder, £17 per ton. (For 1-ton lots and upwards, packed in 1-cwt. bags, carriage paid any station in Great Britain.)

Calcium Chloride, Solid, 70/75%.—Spot, £5 5s. per ton d/d station in drums.

Chrometan.—Crystals, 3½d. per lb.; Liquor, £19 10s. per ton d/d U.K.

Chromium Oxide.—10d.—10½d. per lb., according to quantity, d/d U.K.

Methylated Spirits, 61 O.P.—Industrial, 1s. 8d.—2s. 3d. per gal.; Pyridinized Industrial, 1s. 10d.—2s. 5d. per gal.; Mineralized, 2s. 9d.—3s. 3d. per gal. 64 O.P. 1d. extra in all cases. Prices according to quantity.

Nickel Sulphate.—£52 per ton d/d.

Nickel Ammon. Sulphate.—£52 per ton d/d.

Potash, Caustic.—£30—£33 per ton. Potass. Bichromate crystals and granular.—5d. per lb., net d/d U.K., for spot. Discount according to quantity. Ground, 5¾d. per lb. Potass. Chlorate.—3¾d. per lb. ex whf. Lond. in cwt. kegs.

Potassium Chromate.—6½d. per lb., d/d U.K.

Sal ammoniac, Firsts lump.—Spot, £42 17s. 6d. per ton d/d address in barrels. Chloride of Ammonia.—£37—£45 per ton, carr. paid.

Salt Cake, unground.—Spot, £3 15s. per ton d/d station in bulk.

Soda Ash, 58° E.—Spot, £5 17s. 6d. per ton, f.o.r. in bags, special terms for contracts.

Soda, Caustic, solid 76/77° E.—Spot, £14 5s. per ton d/d station in drums, special terms for contracts.

Soda crystals.—Spot, £5—£5 5s. per ton d/d station or ex depôt in 2-cwt. bags.

Sod. Acetate 97/98%.—£21 per ton. Sod. Bicarbonate (refined).—Spot, £10 10s. per ton d/d station in bags. Sod. Bichromate Crystals, Cake, and Powder.—4d. per lb., net d/d U.K., discount according to quantity. Anhydrous 5d. per lb. Sod. Bisulphite Powder 60/62%.—£16 10s. per ton delivered, 1-cwt. iron drums for home trade.

Sodium Chromate.—3¾d. per lb., d/d U.K.

Sod. Phosphate.—£12 10s. per ton, f.o.r. London, casks free. Sod. Silicate 140° Tw.—Spot, £8 5s. per ton d/d station, returnable drums. Sod. Sulphate (Glauber's Salt).—Spot, £4 2s. 6d. per ton d/d. Sod. Sulphide solid, 60/62%.—Spot, £10 15s. per ton, d/d in drums. Crystals, 30/32%.—Spot, £8 per ton, d/d in casks. Sod. Sulphite, Pea Cryst.—Spot, £13 10s. per ton, d/d station in kegs; Commercial.—Spot, £9 10s. per ton, d/d station in bags.

RUBBER CHEMICALS

Antimony Sulphide.—Golden.—6½d.—1s. 1½d. per lb., according to quality. Crimson.—1s. 3d.—1s. 5d. per lb., according to quality.

Arsenic Sulphide, Yellow.—1s. 5d.—1s. 7d. per lb.

Barytes.—£7 10s.—£9 per ton, according to quality.

Cadmium Sulphide.—3s.—3s. 4d. per lb.

Carbon Bisulphide.—£30—£32 per ton, according to quantity, drums extra.

Carbon Black.—3⅞d.—5⅛d. per lb., ex wharf.

Carbon Tetrachloride.—£41—£46 per ton, according to quantity, drums extra.

Chromium Oxide, Green.—1s. 2d. per lb.

Diphenylguanidine.—2s. 2d. per lb.

India-rubber Substitutes, White.—4¼d.—4⅞d. per lb. Dark.—3½d.—4¼d. per lb.

Lamp Black.—£45—£48 per ton.

Lead Hyposulphite.—9d. per lb.

Lithopone, 30%.—£17 10s.—£18 per ton.

Mineral Rubber "Rupron."—£18 10s. per ton.

Piperidine Rubber Accelerators.—P.P.D.—10s. 6d.—11s. 6d. per lb.; Z.P.D.—7s.—7s. 6d. per lb.; L.P.D.—6s. 6d.—7s. per lb.; P.T.D.—9s. 8d.—10s. 4d. per lb.; C.P.D.—8s. 3d.—8s. 10d. per lb.; S.P.D.—8s. 1d.—8s. 7d. per lb.; P.T.M.—11s. 6d.—12s. 6d. per lb.

Sulphur.—£11 15s. per ton. Sulphur Precip. B.P.—£55—£60 per ton. Sulphur Precip. Comm.—£50—£55 per ton.

Sulphur Chloride.—5d.—7d. per lb., according to quantity.

Vermilion, pale or deep.—4s. 1d.—4s. 6d. per lb.

Zinc Sulphide.—11d.—1s. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

Acetate of Lime.—Brown, £8 10s.—£8 15s. per ton. Grey, £13—£14 per ton. Liquor, Brown, 30° Tw., 6d. per gal.

Amyl Acetate, technical.—95s.—110s. per cwt.

Charcoal.—£6—£11 per ton, according to grade and locality.

Methyl Acetone, 40/50%.—£50—£52 per ton.

Wood Naphtha.—Miscible.—2s. 7d.—4s. per gal. Solvent, 3s. 9d.—4s. 9d. per gal.

Wood Tar.—£2—£6 per ton.

Wood Creosote.—6d.—2s. per gal.

TAR PRODUCTS

Acid Carbolic.—Crystals.—9d.—10d. per lb. Crude 60's, 1s. 11d.—2s. per gal. 2% water—3s. 0¾d. per gal.

Acid Cresylic, 99/100.—11d.—1s. 8d. per gal., according to specification. Refined, 1s. 7d.—1s. 8d. per gal. Pale, 98%, 1s. 2d.—1s. 3d. per gal. 95%, 11d.—11½d. per gal. Dark, 10d. per gal.

Anthracene Oil, Strained, 4½d. per gal.

Benzole.—Prices at works: Crude, 10½d.—11d. per gal.; Standard motor, 1s. 6½d.—1s. 7d. per gal.; 90%, 1s. 7d.—1s. 8d. per gal.; Pure, 1s. 10d.—1s. 11d. per gal.

Xylol.—1s. 11d.—2s. per gal. Pure, 2s.—2s. 2d.

Creosote.—B.S.I. specification, 2½d. per gal., d/d. Heavy—4d. per gal.

Naphtha.—Solvent, 90/160, 1s. 5d.—1s. 6d. per gal. Solvent 95/160, 1s. 7d.—1s. 8d. per gal. Solvent 90/190, 9d.—1s. 2d. per gal.

Naphthalene.—Purified crystals, £9 10s. per ton in bags. Crude, Hot Pressed, £6 5s. per ton. Flaked, £11 per ton.

Pitch, medium, soft.—85s.—90s. per ton, in bulk at makers' works.

Pyridine.—90/140—3s. 9d. per gal.; 90/160—4s.—4s. 6d. per gal.; 90/180—2s.—2s. 3d. per gal.

Toluole.—90%, 2s. per gal. Pure, 2s. 4d. per gal.

PHARMACEUTICAL AND PHOTOGRAPHIC MATERIALS

Acid, Acetic, Pure 80%.—£39 5s. per ton d/d address U.K. in casks.

Acid, Acetyl Salicylic.—2s. 9d.—2s. 11d. per lb., according to quantity.

Acid, Benzoic, B.P.—1s. 9d.—1s. 11d. per lb. Solely ex Gum.—1s. 3d.—1s. 6d. per oz.; 50-oz. lots, 1s. 3d. per oz.

Acid, Boric, B.P.—Cryst., £35 10s. per ton. Powder, £36 10s. per ton. Ex-Fine Powder, £38 10s. per ton. For 1-ton lots and upwards, packed in 1-cwt. bags, carriage paid any station in Great Britain.

Acid, Camphoric.—19s.—21s. per lb.

Acid, Citric.—9¼d. per lb. Less 5%.

Acid, Gallic.—2s. 9d. per lb. for pure crystal in 1-cwt lots.

Acid, Molybdic.—5s. 3d.—5s. 9d. per lb., according to quantity.

Acid, Pyrogallic. Cryst.—6s. 9d. per lb. for 1-cwt. lots Resublimed.—8s. 6d. per lb. for 28-lb. lots d/d.

Acid, Salicylic.—B.P. pulv., 1s. 7d.—1s. 10d. per lb Technical, 1s. 2d.—1s. 4d. per lb.

Acid, Tannic, B.P.—3s. 9d. per lb.

Acid, Tartaric.—11½d. per lb. Less 5%.

Acetanilide.—1s. 5d. per lb.

Ammon. Benzoate.—3s. 3d.—3s. 9d. per lb.

Ammonium Hippurate.—19s. 6d.—23s. 6d. per lb.

Ammonium Iodide.—17s.—17s. 6d. per lb.

Ammonium Molybdate.—5s.—5s. 6d. per lb., according to quantity.

Argent. Nitras, Crystal.—1s. 1d. per oz.

Arsenic Iodide.—22s. 6d.—25s. per lb.

Benzonaphthol.—3s. 3d.—3s. 9d. per lb.

Berberine, Hydrochloride.—5s. 6d.—6s. per oz.; Sulphate, 5s. 6d.—6s. per oz.

Bismuth Salts.—Carbonate, 6s. 10d. per lb.; Citrate 9s. 3d. per lb.; Nitrate (cryst.), 4s. 7d. per lb. Oxide, 10s. 6d. per lb.; Salicylate, 7s. 7d. per lb. Subchloride, 10s. 3d. per lb.; Subgallate, 7s. 3d. per lb.; Subnitrate, 5s. 11d. per lb. Above for cwt. lots Extra and reduced prices for smaller and large quantities respectively. Liquor Bismuthi, P.B. in W. Qts.—1s. 1½d. per lb.; 6 W. Qts.—11d. per lb.; 12 W. Qts.—9½d. per lb.; 36 W. Qts.—9d per lb.

Borax, B.P.—Crystal, £24 10s. per ton. Powder, £2[illegible] per ton. For 1-ton lots and upwards, packed in 1-cwt. bags, carr. paid any station in Great Britain

Bromides, B.P.—Ammonium.—1s. 10d. per lb. Potassium.—1s. 7d. per lb. Sodium.—1s. 9d. per lb Prices for 1-cwt. lots.

Cadmium Iodide.—17s. 6d.—18s. per lb.

Calcium Hippurate.—26s.—30s. per lb.

Calcium Iodide.—20s. per lb.

alcium Lactate, B.P.—1s. 2d.—1s. 4d. per lb., according to quantity.
amphor.—Refined flowers, 3s. 1d.—3s. 2d. per lb. Transparent tablets, 3s. 4d.—3s. 6d. per lb., according to quantity; also special contract prices.
hloroform.—2s. 3d.—2s. 8d. per lb.
inchophen.—11s. 6d.—12s. 6d. per lb.
ocaine, Alkaloid and Citrate.—For export.—29s. 10d.—31s. 7d. per oz. Hydrochloride and Nitrate, 27s. 1d.—28s. 11d. per oz.
phedrine hydrochloride.—5s. 6d.—6s. per oz.
rgosterol.—2s. 6d. per gm.
thers.—S.G. 730, 1s. 1d.—1s. 2d. per lb., according to quantity, and other prices according to specific gravity.
lexamine.—2s. 4d.—2s. 6d. per lb., according to quantity.
lippuric Acid.—17s. 6d.—21s. 6d. per lb.
lydrogen Peroxide (12 vols.).—1s. 4d. per gal., f.o.r. makers' works, naked. B.P.—10 vols., 2s.—2s. 3d. per gal.; 20 vols., 3s. per gal.
lypophosphites.—Calcium, 2s. 9d.—3s. 2d. per lb. Potassium.—3s. 4d.—3s. 9d. per lb. Sodium, 2s. 11d.—3s. 4d. per lb.
odine Resub., B.P.—14s. 8d.—18s. 9d. per lb.
odoform, B.P., Cryst., Precip. or Powder.—17s. 7d.—21s. 7d. per lb.
ron Ammon. Citrate.—B.P.—1s. 10d. per lb. for 28-lb. lots. Green, 2s. 6d. per lb. (list price).
ron Iodide.—17s. 6d.—18s. per lb.
ron Perchloride.—18s.—20s. per cwt., according to quantity.
ron Quinine Citrate, B.P.—9¼d.—9¾d. per oz., according to quantity.
ead Iodide.—14s.—15s. per lb.
ithium Carbonate, B.P., 1914.—5s. 4d. per lb.
ithium Chloride, Cryst.—8s. 3d. per lb.
ithium Citrate.—5s. 3d. per lb. Powder.—5s. 6d. per lb.
ithium Hippurate.—18s. 6d.—22s. 6d. per lb.
ithium Iodide.—20s. 6d.—21s. 6d. per lb.
Magnesium Carbonate.—Light, 28s. per cwt.
Magnesium Oxide.—Light, 70s. per cwt.; Heavy, 1s. 8d. per lb.; in quantity lower.
Menthol.—A.B.R., recryst., B.P., 15s. per lb. net. Synthetic, 8s. 6d.—12s. per lb. Synthetic detached crystals, 8s. 6d.—10s. 6d. per lb., according to quantity; Liquid (95%), 8s. 6d. per lb.
Mercurials, B.P.—Red oxide crystals, 5s. 10d.—5s. 11d. per lb.; Levig, 5s. 4d.—5s. 5d. per lb.; Corrosive sublimate, Lump, 4s.—4s. 1d. per lb.; Powder, 3s. 8d.—3s. 9d. per lb.; White precip., Lump, 4s. 9d.—4s. 10d. per lb.; Powder, 4s. 11d.—5s. per lb.; Calomel, 4s. 9d.—4s. 10d. per lb. Yellow Oxide, 5s. 2d.—5s. 3d. per lb.; Persulph., B.P.C., 4s. 11d.—5s. per lb.; Sulph. nig., 4s. 10d.—4s. 11d. per lb. Special prices for larger quantities.
lercury, Benzoate.—8s. 3d. per lb.; Cyanide, 12s. 7d.—13s. 1d. per lb.; Oleate (5%), 1s. 11d.—2s. 2d. per lb.; (10%), 2s. 9d.—3s. per lb.; (20%), 3s. 9d.—4s. per lb. Protonitras, 6s. 9d. per lb.; Protosulphate, 7s. 3d. per lb.; Subsulphate flav., 7s. 1d. per lb.
lethyl Salicylate.—1s. 4½d.—1s. 6½d. per lb.
'araformaldehyde.—1s. 3d.—1s. 5d. per lb.
'araldehyde.—1s. 1d. per lb.
'henacetin.—4s. 6d.—4s. 9d. per lb.
'henolphthalein.—4s. 5d.—5s. 8d. per lb.
Potass. Bitartrate.—99/100% (Cream of Tartar), 80s. per cwt., less 2½%.
Potass. Citrate.—B.P., 1s. 8d. per lb. for 28-lb. lots.
Potass. Ferricyanide.—1s. 7½d. per lb., in 125-lb. kegs.
Potass. Iodide, B.P.—13s. 15s. 6d. per lb., according to quantity.
Potass. Permanganate.—8¼d. per lb. for 1-ton lots.
Potass. Metabisulphite.—50s. per cwt. d/d London, kegs free.
Potassium Hippurate.—26s.—30s. per lb.
Quinine Sulphate.—1s. 10d. per oz., for 100-oz. tins, tins free.
Saccharin.—37s. 6d. per lb., and lower in quantity.
Salicin.—15s.—16s. per lb., according to quantity.
Santonin, B.P.—28s. per oz.
Seidlitz powder (pulv.).—58s. 9d.—62s. 6d. per cwt.
Silver Nitrate.—1s. 3½d. per oz. for quantity. Sticks, 2d. per oz. extra.
Sod. Barbitonum.—12s. 9d.—14s. per lb.
Sod. Benzoate, B.P.—1s. 7d. per lb., according to quantity.
Sod. Citrate, B.P.C., 1911.—1s. 5d. per lb. B.P.C., 1932, and U.S.P.—1s. 9d. per lb. for 28-lb. lots.
Sodium Hippurate.—23s. 6d.—27s. 6d. per lb.
Sod. Hyposulphite.—Photographic, £15 per ton d/d consignee's station, in 1-cwt. kegs.
Sodium Iodide, B.P.—14s.—17s. 1d. per lb.
Sod. Nitroprusside.—16s. per lb.
Sod. Potass. Tartrate (Rochelle Salt).—70s. per cwt. net for 1-ton lots. Crystals, 2s. 6d. per cwt. extra.
Sod. Salicylate.—Powder, 2s.—2s. 8d. per lb. Crystal, 2s. 1d.—2s. 9d. per lb.
Sod. Sulphide.—Pure recryst., 10d.—1s. 2d. per lb.
Sod. Sulphide anhydrous.—£23—£25 per ton, according to quantity, d/d U.K.
Strontium Iodide.—17s. 6d. per lb.
Tartar Emetic B.P.—3s. 9d.—4s. 6d. per lb.
Terpine hydrate.—1s. 2d.—1s. 5d. per lb.
Thymol, Puriss.—5s. 9d.—6s. 6d. per lb., according to quantity. Natural.—12s. per lb.
Zinc Iodide.—21s.—22s. per lb.
Zinc Stearate.—1s. 4d.—1s. 6d. per lb.

PERFUMERY CHEMICALS

Acetophenone.—7s. per lb.
Aubepine (*ex Anethole*).—8s. per lb.
Amyl Acetate.—2s. 3d. per lb. Amyl Butyrate.—4s. per lb. Amyl Cinnamic Aldehyde.—8s. 3d. per lb. Amyl Salicylate.—2s. 9d. per lb. Anethol, 21/22° C., 4s. 9d. per lb.
Benzaldehyde free from Chlorine.—2s. 9d. per lb.
Benzyl Acetate from Chlorine-free Benzyl Alcohol.—2s. per lb. Benzyl Alcohol free from Chlorine.—2s. per lb. Benzyl Benzoate, 2s. 3d. per lb.
Cinnamic Aldehyde.—Natural, 12s. 3d. per lb.
Citronellol.—6s. 6d. per lb.
Citral.—6s. 6d. per lb.
Coumarin.—15s. per lb.
Ethyl Cinnamate.—8s. 6d. per lb.
Ethyl Phthalate.—2s. 6d. per lb.
Eugenol.—7s. 3d. per lb. Geraniol (Palmarosa).—17s. per lb. Geraniol.—6s. 6d.—11s. per lb. Heliotropine.—6s. per lb. Iso Eugenol.—8s. 6d. per lb. Linalol.—(*ex Bois de Rose*) 6s. 3d. per lb.—(*ex Shui Oil*) 6s. per lb. Linalyl Acetate.—(*ex Bois de Rose*) 8s. 3d. per lb.—(*ex Shui Oil*) 7s. per lb.
Methyl Anthranilate.—9s. per lb.
Methyl Benzoate.—4s. 6d. per lb.

Musk Ketone.—33s. per lb.
Musk Xylol.—8s. per lb.
Nerolin.—5s. per lb.
Phenyl Ethyl Acetate.—10s. per lb.
Phenyl Ethyl Alcohol.—8s. 6d. per lb.
Rhodinol.—60s. per lb. Safrol.—1s. 6d. per lb. Terpineol. 2s. per lb. Vanillin (*ex Clove Oil*).—16s.—18s. per lb.—(*ex Guaiacol*)—14s. 3d.—16s. 3d. per lb.

ESSENTIAL OILS

Almond.—Foreign S.P.A., 9s. 6d. per lb. Anise.—2s. 1d. per lb. Araucaria, 8s. 6d. per lb. Bergamot.—6s. 6d. per lb. Bourbon Geranium, 26s 6d. per lb.
Camphor.—Brown, 80s. per cwt.—White, 85s. per cwt. Cananga, Java, 10s. per lb. Cinnamon Oil. 3s. 9d. per lb. Cassia, 80/85%, 4s. 6d. per lb.
Citronella Oil.—Java, 2s. 9d. per lb. Ceylon, 2s 3d. per lb. Clove.—90/92% English, 5s. per lb.
Eucalyptus, Australian B.P., 70/75%.—1s. per lb. Huon Pine (Methyleugenol, 95%), 16s. per gal. Lavender.—Mont Blanc, 38/40%.—10s. per lb. Lemon.—4s. 3d. per lb. Lemongrass.—3s. per lb. Orange, Sweet.—6s. per lb. Otto of Rose.—Anatolian, 37s. 6d. per oz.; Bulgarian, 55s. per oz. Palma Rosa, 9s. per lb.
Peppermint.—Japanese, 6s 6d. per lb. Wayne County, 14s. per lb. Petitgrain.—5s. 9d. per lb.
Sandalwood, Mysore.—30s. per lb. 90/92%, 20s. per lb. Australian, B.P. and French Codex, 92/95%, 15s. 3d. per lb.

INTERMEDIATES

Items marked thus * d/d buyers' works.

*Acid, Benzoic, 1914 B.P. *ex Toluol*.—1s. 9½d. per lb. in casks.
*Acid Gamma.—Spot, 4s. per lb., 100%.
*Acid H.—Spot, 2s. 4½d. per lb., 100%.
*Acid Neville and Winther.—Spot, 3s. per lb., 100%.
*Acid Sulphanilic, 8d. per lb.
*Aniline Oil, spot, 8d. per lb., drums extra.
*Aniline Salts, spot, 8d. per lb., casks free.
*Benzaldehyde, spot, 1s. 8d. per lb., packages extra.
*Benzidine Base.—Spot, 2s. 5d. per lb., 100%.
o-Cresol 30/31° C.—£2 6s. 5d. per cwt. in 1-ton lots.
m-Cresol 98/100%.—2s. 3d. per lb., in ton lots.
p-Cresol 34.5° C.—1s. 9d. per lb., in ton lots.
Dichloraniline.—2s. 3d. per lb.
*Dimethylaniline.—Spot, 1s. 6d. per lb., packages extra.
Dinitrobenzene.—8d. per lb.
Dinitrotoluene 48/50° C.—8d. per lb. 66/68° C.—8¾d. per lb.
*Diphenylamine.—Spot, 2s. per lb.
*α-Naphthol.—Spot, 2s. 4d. per lb.
*β-Naphthol.—Spot, £78 15s. per ton, in paper bags; £79 15s. per ton in casks, in 1-ton lots.
*α-Naphthylamine.—Spot, 11½d. per lb.
*β-Naphthylamine.—Spot, 2s. 9d. per lb.
o-Nitraniline.—5s. 10d. per lb.
**m*-Nitraniline.—2s. 7d. per lb.
**p*-Nitraniline.—Spot, 1s. 8d.—2s. 1d. per lb.
*Nitrobenzene.—Spot, 4½d. per lb., 5-cwt. lots, drums extra.
Nitronaphthalene.—9d. per lb.
*Sodium Naphthionate.—Spot, 1s. 9d. per lb., 100%.
**p*-Toluidine.—Spot, 1s. 11d. per lb.
**o*-Toluidine.—Spot, 9½d. per lb., drums extra.
m-Xylidine acetate, 3s. 4d. per lb., 100%.

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development a Intelligence), 35, Old Queen Street, London, S.W has received the following inquiries for British goo British firms may obtain further information by apply to the Department and stating the specific numb *Argentina:* Turpentine (B.X. 7554). *Canada:* For chromium-steel valves and pipe fittings for chemi works, paper mills, etc. (611); Industrial chemic for paper, including sodium di-phosphate, sodium sulphate, etc. (619); Sulphate of alumina, calci chloride and copper sulphate, water-filtration equ ment (620). *Cuba:* Tinplate, linseed, and paint (638). *Czechoslovakia:* Indigo, bromide, raw iodi casein, essential oils, castor oil, soya-bean oil (6 *Egypt:* Diesel generating set (A.X. 11,783). *Palesti* Paper, paint (622). *Poland:* Drugs and pharmaceuti chemicals (634). *South Africa:* Edible oils (623).

Dyestuffs (Import Regulation) Act, 1920

The following statement relating to applications licences under the Dyestuffs (Import Regulation) A 1920, made during April, has been furnished to Board of Trade by the Dyestuffs Advisory Licens Committee. The total number of applications recei during the month was 505, of which 462 were fr merchants or importers. To these should be ad 10 cases outstanding on March 31, making a total for month of 515. These were dealt with as follows Granted, 501 (of which 491 were dealt with within 7 d of receipt); referred to British makers of sim products, 13 (of which 11 were dealt with within 7 d of receipt); outstanding on April 29, 1. Of the t of 515 applications received, 502 or 97% were dealt w within 7 days of receipt.

Trade Marks Committee, 1933

The Trade Marks Committee which was set up January under the chairmanship of the Rt. H Viscount Goschen to consider and report whether a and if so what, changes in the existing law and prac relating to trade marks are desirable, are contin their meetings for the purpose of hearing evidence f interested persons and associations. During the few weeks evidence will be taken from representat of the Trade Marks, Patents and Designs Federat Ltd., the Trade Mark Owners' Association, Ltd., the Chartered Institute of Patent Agents.

Any persons or associations who desire to submit further suggestions, or to give evidence, should no their intention to the Secretary of the Commit Mr. R. W. Luce, Industrial Property Departm Board of Trade, 25, Southampton Buildings, W. not later than June 3 next.

PUBLICATIONS RECEIVED

GAS ANALYSIS BY MEASUREMENT OF THERMAL CON TIVITY. By H. A. Daynes, D.Sc. Pp. viii + London: Cambridge University Press, 1933. 16s.

REVIEW OF IRON AND STEEL LITERATURE FOR 1932. E. H. McCLELLAND. Reprinted from "The B Furnace and Steel Plant," January—February, 1 Pp. 27. Pittsburgh: Carnegie Library of Pittsbu 1933.